Revelstoke
Timber Supply Area
Analysis Report

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Preface

This report contains a timber supply analysis and a socio-economic analysis and is part of the provincial Timber Supply Review (TSR) carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia.

To determine allowable timber harvesting levels, the chief forester must have an up-to-date assessment of the timber supply based on the best available information and current management direction. **The report that follows provides this assessment but should not be considered as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario that reflects current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, forest practices legislation and official land-use decisions made by Cabinet.

Focussing the assessment on the implications of current practices rather than looking at a number of different management regimes expedites the analysis process. In addition, it reflects that the chief forester does not have the legal authority to establish land use and management direction as part of allowable annual cut (AAC) determination.

An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of timber supply and related forest characteristics under current forest management provide a basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the AAC, the chief forester considers short- and long-term implications of alternative harvest levels, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

This report is the second of four documents that will be released for each TSA as part of the timber supply review. The first document is the data package, a revised version of which is included as an appendix to this report. A third document called the public discussion paper summarizes the technical information and provides a focus for public discussions of possible timber harvest levels. The fourth document outlines the chief forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Revelstoke Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the short- (next 20 years), medium- (21 years to 140 years from the present) and long- (beyond 140 years from the present) terms. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. The forecasts are intended for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Revelstoke TSA covers about 550 000 hectares in the southeastern portion of British Columbia. About 65% of the Crown productive forest is considered to be unavailable for timber harvesting at this time due primarily to economic or physical operability and environmental sensitivity. About 78 000 hectares of the area are considered available for timber production and harvesting under current management practices. Within the area available for timber harvesting, most of the forests are dominated by western hemlock and western redcedar tree species at lower elevations, and Engelmann spruce and subalpine fir at higher elevations. Smaller areas are also dominated by Douglas-fir, western white pine, lodgepole pine and larch. Western redcedar, western hemlock, Engelmann spruce, subalpine fir and Douglas-fir are the tree species most commonly used by the forest industry in the area.

Current forest management practices follow existing forest legislation and standards. In addition, practices are guided by the Revelstoke and Area Land Use Planning Minister's Advisory Committee (MAC) recommendations on forest management.

The results of the 2004 timber supply analysis for the Revelstoke TSA suggest that, given data and assumptions that reflect our current level of understanding about forest management objectives and practices, the current allowable annual cut in the Revelstoke TSA of 230 000 cubic metres can be maintained for twenty years. After twenty years, the projected harvest level declines for the subsequent three decades by 10% per decade, and then by an additional 3%, before a mid-term harvest level of 165 000 cubic metres per year is attained. The harvest level then remains at that level until the 14th decade, when it increases by 3.2% to a long-term level of 170 500 cubic metres per year.

A series of sensitivity analyses illustrate that uncertainties in data or management practices can affect the timber supply projections to varying degrees. The resulting changes in assumptions can either increase or decrease available timber supply.

Factors affecting short-term timber supply

The base case illustrated a stable harvest in the short term, measured over the first twenty years of the analysis horizon, at the level of the current AAC. Other than in one alternative harvest flow in which an initial harvest level higher than in the base case was shown to be possible for one decade, increases in short-term timber supply relative to the base case were not attempted in the sensitivity analyses.

Analysis showed that uncertainties associated with three issues, the size of the timber harvesting land base, existing stand volume estimates and caribou management, could result in a reduction in short-term timber supply.

Decreasing the timber harvesting land base by 13%, to the size of the timber harvesting land base in the 1998 analysis, had an impact of about 14% on short-term timber supply. However, there is no data to suggest that the timber harvesting land base has been overestimated by this amount. Two sources of uncertainty do exist around the size of the timber harvesting land base: the merchantability of hemlock-leading stands, and a possible land base exclusion for a ski resort. Assuming that all sites currently occupied by stands comprised of more than 59% hemlock species were not harvestable (about 19% of the timber harvesting land base) would result in a 30% impact to short-term timber supply. If only those sites with stands of more than 79% hemlock species were not harvestable (about 5% of the timber harvesting land base), the timber supply reduction in the short term would be 14%. A smaller short-term impact would result if the Mount MacKenzie ski resort proposal area became unavailable to contribute to timber supply, which would reduce the size of the timber harvesting land base by about 2.5%. Short-term timber supply would be impacted by about 2.5% in this case.

Executive Summary

If existing unmanaged stands had 10% less volume than in the base case, short-term timber supply is reduced by about 14%. While there is some uncertainty about volumes in existing stands, for example, related to estimates of losses to decay, there is no evidence to indicate that existing stand volumes are overestimated by 10%. This issue was examined primarily to inform decision-making about which factors are most important in defining timber supply.

Almost 45% of the timber harvesting land base is subject to requirements for caribou habitat management. The base case timber supply projection was unaffected by minor adjustments in the application of the caribou habitat guidelines. However, if management for caribou habitat were to apply to either a larger operable area or the requirements for mature forest cover were to increase, short-term timber supply could be significantly impacted. Short-term timber supply reductions ranged from about 5% if the operable area subject to management were increased to 22% if this occurred in conjunction with increased retention of mature seral forest. Relaxing the habitat management for moose and deer did not mitigate the short-term impacts.

All of the uncertainties examined above affected mid- and long-term timber supplies to varying degrees.

Factors affecting mid-term timber supply

Some uncertainties did not affect short-term timber supply but did affect the mid-term supply.

Sensitivity analysis related to the following changes indicated substantial increases in mid-term timber supply relative to the base case: increases in the size of the timber harvesting land base; increases in estimates of volumes in unmanaged stands; application of old-growth order requirements for landscape-level biodiversity rather than the recommendations of the MAC; and reduction in the level of natural disturbance in the non-timber harvesting land base to about half of that in the base case.

Smaller but still significant increases could occur if old-growth site index adjustments accurately reflect future growth of managed stands, modifications were made to the application of landscape-level biodiversity requirements (i.e., phase in of old-seral requirements, no application of mature-seral requirements, or no proportional representation), or higher disturbance rates were acceptable in visually sensitive areas.

Uncertainties or changes that could result in lower mid-term timber supply include decreased merchantability of hemlock stands and modifications to caribou habitat requirements to cover larger areas or higher levels of retention.

Factors affecting long-term timber supply

Long-term steady timber supply is affected by changes in several factors. The most influential factors the size of the timber harvesting land base size, particularly as related to the uncertain merchantability of hemlock stands; site productivity of future managed stands; the amount of area managed for caribou habitat and the forest retention requirements applied in the habitat areas; and the rate of disturbance in the forest outside the timber harvesting land base.

Socio-economic assessment

A socio-economic assessment indicates that the forest industry is the largest private sector source of basic income in the Revelstoke TSA economy.

Within the Revelstoke TSA, the current level of harvesting supports an estimated 315 person-years of employment annually (includes direct, indirect and induced jobs) and $9.94 million in employment income. Provincially, the harvest from the Revelstoke TSA supports 638 full-time jobs, $18.55 million in employment income and $3.23 million in gross provincial revenues.

The base case harvest forecast for the Revelstoke TSA indicates a stable timber supply for the first 20 years, with reductions starting in decade 3. Assuming existing harvesting and milling productivities do not change, the current average employment and income levels will remain about the same, with variations in annual employment as a result of fluctuating harvest levels.

The stability in timber supplies for the first two decades should also provide sufficient time for other sectors to respond, providing greater economic diversification and stability.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth pattern. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or recreation.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The provincial forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Revelstoke TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Section 3 outlines the timber supply analysis methodology. Timber supply analysis results are presented in Section 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used, and is followed by a summary and conclusions in Section 6. Section 7 shows results of a socio-economic analysis for the Revelstoke TSA. Appendix A contains further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis (Section 7) provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Revelstoke TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and assessing employment and income implications of the timber harvesting levels projected in the base case.

The analysis includes estimates of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and woodlands-related activities, processing, and silviculture. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

1 Description of the Revelstoke Timber Supply Area

The Revelstoke timber supply area (TSA) lies in the southeastern part of British Columbia within the Southern Interior Forest Region (Figure 1), and is administered from the Columbia Forest District office in Revelstoke. It is bounded by the Monashee mountains to the west and the Selkirk mountains to the east, and straddles the Columbia River valley, which runs from the Mica Dam in the north to Monashee Provincial Park and Arrowhead in the south. The Trans-Canada Highway passes through the southern part of the area, providing easy access to an area of outstanding mountain scenery. Nearby are Mount Revelstoke National Park, a portion of Glacier National Park and several smaller provincial parks.

The Revelstoke TSA covers about 550 000 hectares. Of this, about 51% is classified as non-forested land including alpine areas, lakes, swamp, brush or rock. About 41% of the Revelstoke TSA is considered productive forest in terms of timber growth, and is dominated by forests of western hemlock, western redcedar, Engelmann spruce and subalpine fir tree species. Smaller areas of forest are covered predominantly by Douglas-fir, western white pine, lodgepole pine, larch, cottonwood, birch and aspen.

The area's economy is relatively well diversified with forestry, tourism and the public sectors predominant. Information from a 2001 economic dependencies report indicates that the forest sector accounted for 23% of total employment in the Revelstoke TSA. Processing facilities within the TSA include two sawmills, a pole yard and two smaller lumber mills. Western redcedar, western hemlock, Engelmann spruce, subalpine fir and Douglas-fir are the species most commonly used by the forest industry in the area. The current allowable annual cut for the Revelstoke TSA, determined in 2000, is 230 000 cubic metres.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

1.1 The environment

The Revelstoke TSA lies in the interior-wet belt of the province, and overlaps with three biogeoclimatic zones*: interior-cedar-hemlock (ICH), Engelmann spruce-subalpine fir (ESSF) and alpine tundra (AT). The area's topography is characterized by rugged, mountainous terrain, and a cold, wet climate. The mountainous environment creates varied growing conditions resulting in diverse forests and high biodiversity* values. Valley bottoms are covered with western redcedar and western hemlock stands, with Engelmann spruce and subalpine fir on higher elevation slopes. The mountain peaks are covered by vast expanses of alpine tundra, rock and ice. As a result of this rugged landscape and cold, wet climate, a relatively small proportion (13.5%) of the Revelstoke TSA is available for timber harvesting.

The forests of the Revelstoke TSA provide habitat for a wide variety of wildlife species. These include black and grizzly bear, caribou, moose, deer, elk and mountain goat as well as smaller mammals such as marmots, martens and squirrels.

Table 1 summarizes the biogeoclimatic zones and their locations, the tree species present and other conditions such as wildlife values.

More than 60% of the Revelstoke TSA forest is old growth, which provides habitat for mountain caribou, cavity-nesting birds and small mammals such as the pine marten and certain species of bats. Cavity-nesting birds, including woodpeckers and owls, depend on large-diameter snags and uneven-aged forests, particularly at lower elevations.

The Revelstoke TSA overlaps the range of one of the largest and most viable populations of threatened mountain caribou in western Canada. These caribou require mature lichen-bearing forests for foraging, and ecosystems with relatively few other ungulates* and their predators.

The main fishing lake in the Revelstoke TSA is Lake Revelstoke with kokanee and rainbow trout being the primary species caught.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Ungulate
A hoofed herbivore, such as deer.

1 Description of the Revelstoke Timber Supply Area

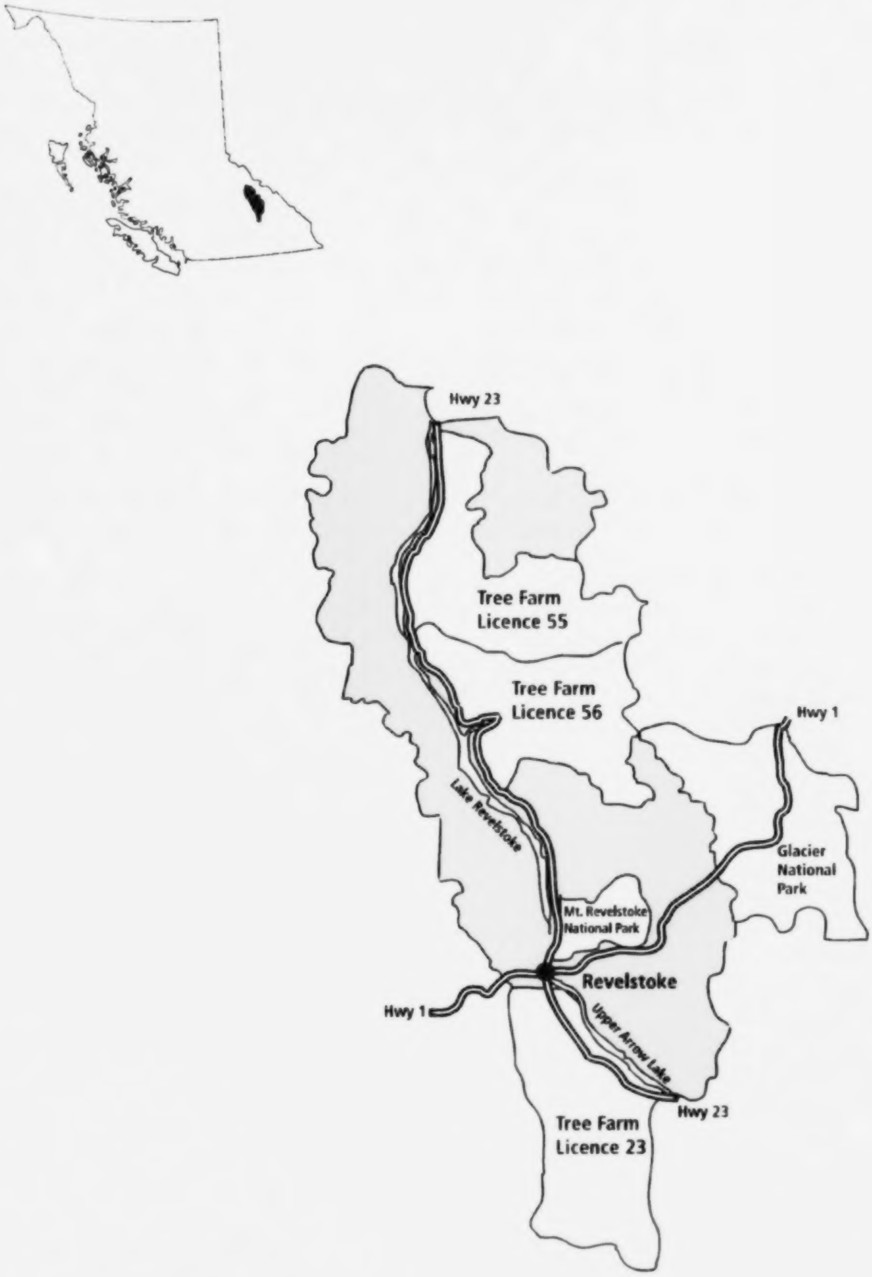
Hwy 23
Tree Farm Licence 55
Tree Farm Licence 56
Hwy 1
Lake Revelstoke
Glacier National Park
Mt. Revelstoke National Park
Revelstoke
Hwy 1
Upper Arrow Lake
Hwy 23
Tree Farm Licence 23

Figure 1. Map of the Revelstoke Timber Supply Area.

1 Description of the Revelstoke Timber Supply Area

Table 1. Biogeoclimatic zones of the Revelstoke timber supply area

Zone	Location	Tree species	Other
Interior cedar-hemlock (ICH)	Occupies valley bottoms and lower slopes (to 1500 metres).	Dominant: Western hemlock Western redcedar Minor: Engelmann spruce Hybrid white spruce Subalpine fir Lodgepole pine Western white pine Western larch Douglas-fir	Cool winters with heavy snow; warm, dry summers. This is the most productive forest zone in interior B.C. and has the highest diversity of tree species of any biogeoclimatic zone. Wildlife is constrained by deep winter snows.
Engelmann spruce-subalpine fir (ESSF)	Above interior cedar-hemlock and below alpine tundra (1500 to 2250 metres).	Dominant: Engelmann spruce Subalpine fir Minor: Lodgepole pine Whitebark pine Western white pine Douglas-fir Mountain hemlock Western hemlock Western redcedar	Short, cool growing season. Long, cold winters with heavy snow. Wildlife constrained by deep snows and steep slopes.
Alpine tundra (AT)	Above 2250 metres.	Stunted trees at lower elevations of zone, otherwise treeless.	Cold, windy and snowy. Low growing season temperatures. Wildlife species and diversity are low.

Table 2 summarizes the animal species considered at risk in the Columbia Forest District, which includes the Revelstoke TSA. In addition, 14 plant species are red-listed (endangered or threatened) and 32 plant species are blue-listed.

Table 2. Vulnerable, endangered and threatened species that breed in the Columbia Forest District

Endangered or threatened (red-listed)	**Vulnerable (blue-listed)**	
Mountain caribou (*southern population)*	Albert's Fritillary	Great Blue Heron
Fisher	American Bittern	Grizzly Bear
Northern Leopard Frog	Bighorn Sheep	Mead's Sulphur
Vivid Dancer	Bull Trout	Northern Long-eared Myotis
White Sturgeon	Cutthroat Trout (*lewisii*)	Painted Turtle
	Forcipate Emerald	Short-eared Owl
		Wolverine (*luscus*)

Source: B.C. Conservation Data Centre June 2004.

Under provisions of the *Forest Practices Code** and the new *Forest and Range Practices Act* and regulations a process exists for identifying species at risk and designating wildlife habitat areas (WHA) with specific management practices. The wildlife species that have been identified within the Columbia Forest District, which includes the Revelstoke TSA are listed in Table 3.

Table 3. Columbia Forest District identified wildlife

Common name of identified wildlife
Amphibians
Coeur d'Alene Salamander
Northern Leopard Frog
Birds
Lewis's Woodpecker
Short-eared Owl
Mammals
Badger
Grizzly Bear
Mountain Caribou (northern populations)
Wolverine

Source: Identified Wildlife Management Strategy (IWMS) 2004.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

1 Description of the Revelstoke Timber Supply Area

Current forest management practices follow the standards and legislation set out by the *Forest Practices Code*. The *Forest and Range Practices Act* will guide practices after it is fully implemented, which is expected to occur by December 2005. As well, recommendations from the Revelstoke and Area Land Use Planning Minister's Advisory Committee are being implemented to manage landscape-level biodiversity*, visual values, and habitat for caribou and other ungulates in the Revelstoke TSA.

Mountain caribou is closely associated with old-growth forests. The conversion of mature and old-growth forests to younger, managed stands after harvesting can affect mountain caribou both directly and indirectly. Direct impacts can result from loss of habitat, since mountain caribou rely on mature forest cover at a range of elevations to meet their habitat needs (that is, food, like arboreal lichen, and travel). Indirect negative impacts on caribou from conversion to younger stands can stem from increased presence of other ungulates and their associated predators, since moose and deer benefit from increased forage following timber harvesting. Further, increased interaction with humans can affect caribou.

Moose and deer benefit from increased forage following timber harvesting; however, roads associated with harvesting typically increase human access for hunting or recreation. Negative impacts can be minimized through appropriate access management.

1.2 First Nations

The Revelstoke TSA is within the traditional lands of the Shuswap Nation, the Ktunaxa/Kinbasket Nation and the Okanagan Nation. There are currently no First Nation reserves or communities within the TSA.

The Ktunaxa Kinbasket Tribal Council, of which the Shuswap Indian Band and Akisq'nuk First Nation are members, is currently negotiating a comprehensive treaty agreement, which addresses all of the substantive matters required to conclude a final treaty agreement for an area in the southeast corner of B.C., including the Revelstoke TSA.

Additionally, the Ktunaxa Kinbasket Tribal Council has been provided a written offer of a Forest and Range Agreement (FRA) on behalf of its member Bands. This FRA provides accommodation for the economic component of aboriginal interests that may be impacted by forestry decisions made within asserted traditional territory for the term of the FRA.

Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield; and management practices. These three categories are discussed below. Also, in preparation for the analysis, a number of changes since the 1998 Revelstoke TSA timber supply analysis were noted, and are described in Section 2.4, "Changes since the 1998 Revelstoke TSA analysis."

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 2002 by the B.C. Forest Service. This file contains information on the forest land in the Revelstoke TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability*). The file was updated for silviculture and harvesting activities to 1999. Stand attributes such as tree height, stocking* and age have been projected to 2002.

The inventory file represents the land base for the entire TSA. It includes information on land that is covered with forest as well as other areas where timber harvesting is not expected to occur. Examples of the latter category are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Revelstoke TSA is provided below. These types of areas do not contribute directly to timber supply in the Revelstoke TSA, and are identified and excluded from the timber harvesting land base* before assessing timber supply.

Identifying areas as not contributing to timber supply does not mean the area is removed from the Revelstoke TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas that do not contribute to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value, and sites of adequate environmental resilience, to accommodate timber harvesting with due care for other resources.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

2 Information Preparation for the Timber Supply Analysis

For the Revelstoke TSA, the following types of areas were excluded from the timber harvesting land base:

- areas not managed by the B.C. Forest Service — non-Crown areas such as private land and Indian Reserves, areas managed by other Crown agencies, such as parks, and land in woodlot licences* not administered as part of the TSA.
- non-forest areas — areas that are not occupied by productive forest cover (e.g., rock, ice, alpine areas and water bodies).
- non-commercial cover areas — areas that are occupied by non-commercial tree and brush species.
- inoperable areas* — areas that are classified as unavailable for harvest for terrain-related or economic reasons.
- existing roads, trails and landings (RTLs) — areas that are occupied with permanent access structures and as a result are no longer available to contribute to timber production.
- riparian areas* — areas that are reserved from harvesting to provide protection for riparian and stream ecosystems.
- environmentally sensitive areas (ESAs)* — areas with sensitive soils, high avalanche risk, or potential regeneration difficulty if the existing trees are harvested.
- sites with low timber productivity — areas that are occupied by forest with low timber growing potential, due to inherent site factors such as nutrient availability, exposure, moisture, etc. These areas have small sized and/or low volume trees that do not currently meet criteria for harvest.
- non-merchantable forest types* — forest types currently considered not economic for harvesting because they contain too high a proportion of poor quality trees or low value timber species.

Woodlot licence
An agreement entered into under the Forest Act. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

A more detailed description of these categories, including specific criteria for exclusion is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 4 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Crown productive forest area by classification" provides the total forested area managed by the B.C. Forest Service within the given category. For example, while there is a total of 22 442 hectares of forested land classified as low productivity sites, only 743 hectares were excluded at that point of the land base determination. The difference arises because the actual area excluded depends on the sequence of the reduction (e.g., areas excluded in a previous step as inoperable may have overlapped with low productivity stands, thus reducing the area explicitly excluded due to low productivity).

2 Information Preparation for the Timber Supply Analysis

Table 4. Determination of the timber harvesting land base for the Revelstoke TSA

Classification	Area (ha)	Area removed/added in sequence (ha)	Total Crown productive forest by classification[a] (ha)	Per cent of Crown productive forest area[a] (%)	Per cent of total TSA area[b] (%)
Total TSA area	**549 420**				100.0
Not managed by the B.C. Forest Service[c]		48 256	—	—	8.8
Non-forest land		278 342	—	—	50.7
Total of non-forest and areas not managed by the B.C. Forest Service	326 598		—	—	59.4
Total forested area managed by the B.C. Forest Service (Crown productive forest)[d]	**222 822**		**222 822**	100.0	**40.6**
Reductions to Crown productive forest:					
Non-commercial cover		113	113	0.1	0.0
Inoperable		129 334	129 365	58.4	23.7
Existing roads, trails and landings		1 810	2 460	1.6	0.7
Riparian buffer areas		1 317	2 758	2.8	1.1
Environmentally sensitive areas		4 388	39 798	18.3	7.4
Low productivity sites		743	22 442	10.2	4.1
Problem forest types		2 828	5 312	2.5	1.0
Reductions for stand-level biodiversity (wildlife trees)		3 154	3 154	1.4	0.6
Timber Licences (TLs)[e]		1 117	2 587	1.2	0.5
Total current reductions[f]	**144 804**	144 804		**65.0**	**26.4**
Current timber harvesting land base[g]	**78 018**		78 018	**35.0**	**14.2**
Future land base changes					
Timber licences (added)[e]		1 117	1 117	0.5	0.2
Future roads (deleted)[h]		2 898	2 898	1.3	0.5
Future timber harvesting land base	**76 237**		76 237	**34.2**	**13.9**

(a) The "Total Crown productive forest" column displays the total forested area in each category before application of any land base exclusions. The "Per cent of Crown productive forest area" column is the total Crown productive forest by category divided by the total Crown productive forest area (222 822 hectares), except for "Total current reductions" for which the total of the sequential reductions was used.

(b) For non-Crown and non-forest this is the "Area removed/added" column divided by the total area (549 420 hectares). For areas in the Crown productive forest, this is the "Total Crown productive forest by classification" divided by the total area.

(c) Includes private land, national and provincial parks, unavailable reserves and woodlots.
The total area in woodlots is 1165 hectares and is excluded from the timber harvesting land base.

(d) This area (222 822 hectares), minus the non-commercial cover area (113 hectares) and the existing roads, trails and landings (1810 hectares) as deducted below, is hereafter referred to in the report as total Crown productive forest.

(e) Areas in TLs covered with stands 70 years of age and older were first deducted from the timber harvesting land base, and then assumed to revert to the timber harvesting land base 20-30 years into the analysis horizon.

(f) The sum and percentages listed in this row apply to the sequential reductions.

(g) Includes 1483 hectares of current NSR and 1727 hectares of backlog NSR. Also includes 1039 hectares of Timber Licences covered with stands less than 70 years old which were assumed to have already been harvested and reverted to the timber harvesting land base at the start of the analysis horizon.

(h) Exclusions for future roads, trails and landings were based on ISIS data. Area lost to permanent access averaged 6% in each treatment unit over the past 5 years. It is assumed this trend will continue into the future. A 6% land base reduction was applied to areas when the unmanaged stands occupying them were harvested for the first time only.

2 Information Preparation for the Timber Supply Analysis

Table 5 shows the areas both within the TSA and within adjacent parks that contribute to forest management requirements for biodiversity. The total forested area of the Revelstoke area is 233 627 hectares. The bulk of that area is within the TSA (222 822 hectares), but 10 805 hectares of forest within parks also contributes to biodiversity requirements.

Forested area in adjacent parks is normally included in the analysis area since it contributes to biodiversity requirements. However, due to the implementation of forest cover requirements in the Revelstoke TSA according to the Revelstoke and Area Minister's Advisory Committee (MAC) recommendations, inclusion of the parks would have no impact on the timber supply forecast. Therefore, the forested park area was not included in the analysis. The reason for a lack of impact is that under the MAC recommendations, specified amounts of old and mature forest should be reserved on the Crown productive forest land base both above and below the operability line (i.e., proportional representation). However, there is no operable area in parks (since no operability classification was done in those areas). Therefore, the parks do not contribute to seral requirements below the operability line. Under proportional representation, only forest cover requirements below the operability line will potentially affect timber supply, and therefore inclusion of the parks would not affect analysis results.

Table 5. Total forested area in the Revelstoke area, including parks — Revelstoke TSA, 2004

	Landscape unit	Area (hectares)
National parks	LaForme (R10)	3 207
	Illecillewaet (R20)	7 273
Provincial parks	LaForme (R10)	4
	Mulvehill (R4)	180
Reserves	Illecillewaet (R20)	10
	Akolkolex (R3)	31
	Jordan (R7)	65
	Jordan (R7)	34
Total forested area of parks in the analysis area		**10 805**
Total Crown productive forest managed by the B.C. Ministry of Forests[a]		**220 899**
Forested portion of the Revelstoke analysis area		**231 704**

(a) The total productive forest area managed by the B.C. Ministry of Forests excludes existing roads (1810 hectares) and non-commercial cover (113 hectares).

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents the total Revelstoke TSA and the Crown productive forest land base. The chart shows that about 8.8% of the total land base is not managed by the B.C. Forest Service, and 50.7% is non-forest or non-productive forest (i.e., having very few trees). The Crown productive forest area chart details the categories of forest land and shows that about 65% of the forest land in the Revelstoke TSA is considered to be unavailable for harvesting, primarily due to operability, and to a lesser extent environmental sensitivity. Approximately 35% of the Crown productive forest area is considered available for timber harvesting (including areas currently covered with stands considered not satisfactorily restocked (NSR)*).

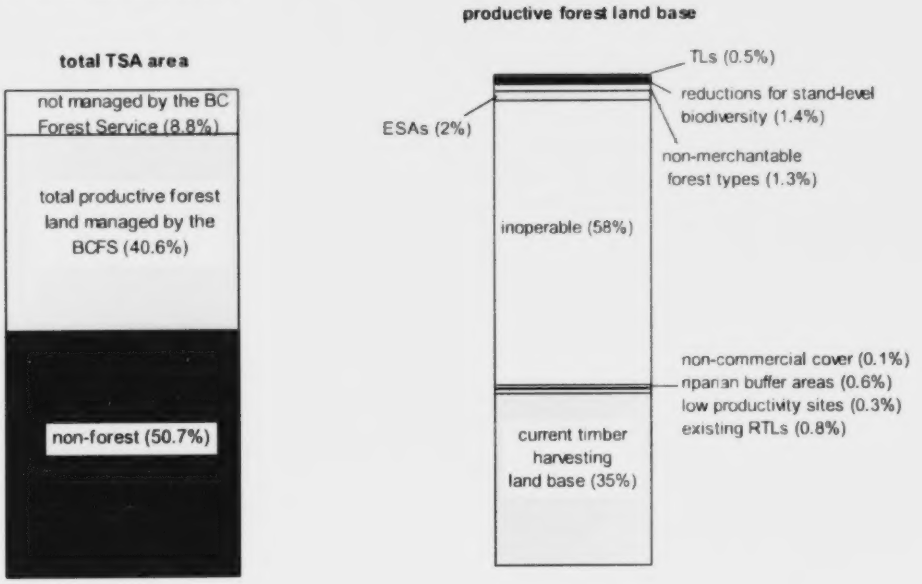

Figure 2. Composition of the total and Crown productive forest land bases — Revelstoke TSA, 2004.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the distribution of biogeoclimatic (BEC) variants in the total Crown productive forest area and in the timber harvesting land base of the Revelstoke TSA.

Table 6 provides a tabular view of the location of the BEC variants in relation to the Crown productive forest, the timber harvesting land base, and the operable land base. The first two columns of Table 6 show the per cent of the Crown productive forest and of the timber harvesting land base that is in each BEC variant. These columns provide an idea of the prevalence of each BEC variant in the TSA. The third column shows the per cent of the operable land base that is in the timber harvesting land base. In the Revelstoke TSA, the Minister's Advisory Committee recommendations include the requirement to reserve specified amounts of old and mature forest on the Crown productive forest land base both above and below the operability line (i.e., proportional representation). If a large proportion of the operable land base is within the timber harvesting land base, there is less forest outside the timber harvesting land base to contribute to the forest cover requirements applicable to the operable land base, and the higher the potential timber supply impacts of those requirements. While for some values (e.g. caribou), a previous operability line was used when delineating the management zone, the area below the current operability line can still provide a better idea of the contribution of forest outside the timber harvesting land base to mature and old forest requirements than would the total Crown productive forest area.

In general, a high proportion of the operable land base is within the timber harvesting land base for most variants. This suggests that mature and old forest requirements could have a significant effect on timber availability, which is verified by the analysis results (see Section 5.7, "Uncertainty in the application of landscape-level biodiversity objectives").

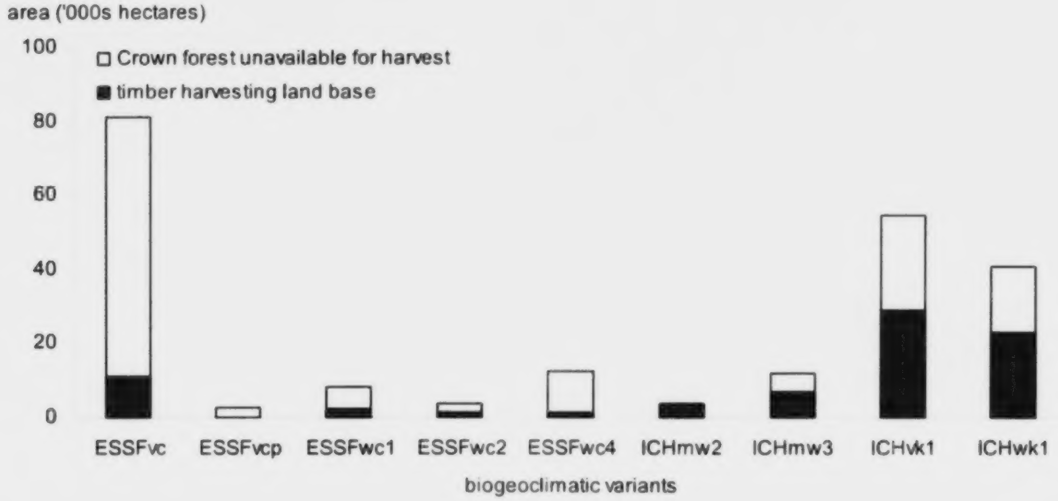

Figure 3. Area by biogeoclimatic classification — Revelstoke TSA, 2004.

Table 6. Summary of biogeoclimatic zone areas — Revelstoke TSA, 2004

BEC variant	% of total Crown productive forest in the BEC variant	% of timber harvesting land base in BEC variant	% of operable area that is in the timber harvesting land base
ESSFvc	36.7	13.9	90.4
ESSFvcp	1.2	0.0	0
ESSFwc1	3.8	3.0	76.9
ESSFwc2	1.7	1.6	91.1
ESSFwc4	5.6	2.3	78.1
ESSFwcp2	0.1	0.0	0
ICHmw2	2.1	4.4	83.2
ICHmw3	5.5	8.7	77.7
ICHvk1	24.8	36.4	90.3
ICHwk1	18.5	29.6	83.2
	100	100	Not applicable

Figure 4 shows the composition of stands by dominant tree species on the Revelstoke TSA timber harvesting land base at the start of the analysis horizon. Stands dominated by hemlock are the most prevalent, comprising 27% of the timber harvesting land base. Stands dominated by cedar comprise 22% of the timber harvesting land base. Stands comprised primarily of balsam (*Abies*, true fir), pure spruce, or spruce-balsam mixes (balsam spruce on the figure below) are the next most numerous, comprising 21% of the timber harvesting land base. Mixed and pure stands of fir, larch and pine, and spruce mixed with species other than balsam comprise 16% and 14% of the timber harvesting land base, respectively.

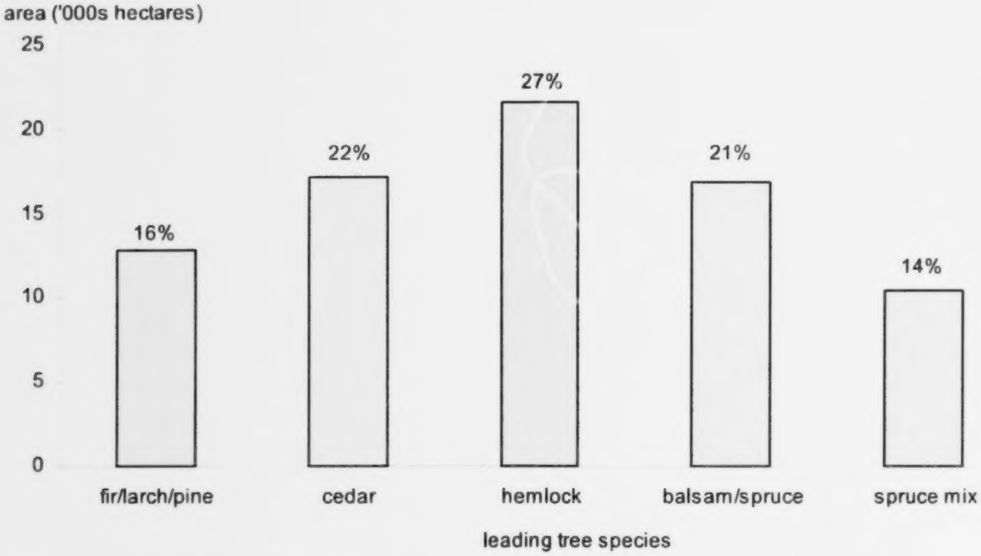

Figure 4. Area by dominant species — Revelstoke TSA timber harvesting land base, 2004.

Following harvest, fir, larch and pine stands are regenerated to Douglas-fir dominated stands with a more minor component of larch and pine or just pine on poorer sites. Hemlock stands on poor sites are regenerated to Douglas-fir dominated stands, with components of spruce and hemlock. All other stands are regenerated to spruce dominated stands with varying mixtures of cedar, Douglas-fir, hemlock and balsam (see Appendix A, "Description of Data Inputs and Assumptions for Timber Supply Analysis" for more details on the regeneration regime modelled in the analysis). It is assumed that 20% of the timber harvesting land base will be regenerated to fir-leading stands over time, and the remainder to stands dominated by spruce mixed with the other species.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the composition of stands by dominant tree species on the Revelstoke TSA timber harvesting land base at the start of the analysis horizon, grouped by leading species and age. Managed stands are those 25 years of age or younger; thrifty/unmanaged stands are those older than 25 years of age but less than 140 years of age; mature stands are at least 140 years of age but less than 250 years of age, and old stands are those 250 years of age or older.

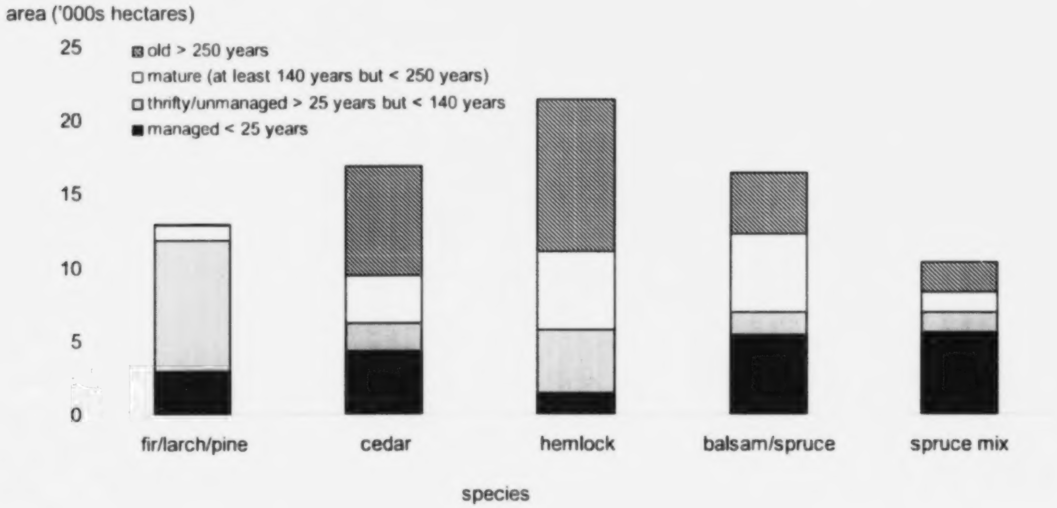

Figure 5. Area by age classification — Revelstoke TSA timber harvesting land base, 2004.

About 19 400 hectares, or 25% of the timber harvesting land base, has a history of harvest and subsequent management treatments. Over half of this area is currently regenerating to stands comprised primarily of spruce or balsam, with a further quarter regenerating to cedar-dominated stands. The species composition of the managed stands currently on the timber harvesting land base differs somewhat from the expected species composition in future managed stands described previously.

The remaining three-quarters of the timber harvesting land base is comprised of unmanaged stands. About 41 000 hectares, or over half of the timber harvesting land base, is in stands 140 years of age or older. These stands are dominated by hemlock species (38%), cedar (26%) and balsam spruce (23%). Under the base case assumptions, 9600 hectares or one-quarter of these mature and old stands on the timber harvesting land base are never harvested, as their reservation is required throughout the analysis horizon to meet various objectives for old and mature forest.

In total, 18% of the long-term timber harvesting land base is never harvested. Two-thirds of this area (12% of the timber harvesting land base) is comprised of these original old stands. The remaining 6% is comprised of the original thrifty stands (those between 25 and 140 years of age at the start of the analysis) also never harvested, but retained to meet the same objectives.

Figure 6 depicts the distribution of site productivity of stands on the timber harvesting land base. The figure shows the composition by species and site index (SI)* group.

In the analysis, stands were grouped according to their site indices into categories of relative site productivity: good, medium, or poor. These groupings were used to project expected volumes over time for stands of similar species composition and site productivity. The site index thresholds used to group the stands varied somewhat by dominant species depending on the range observed for each species.

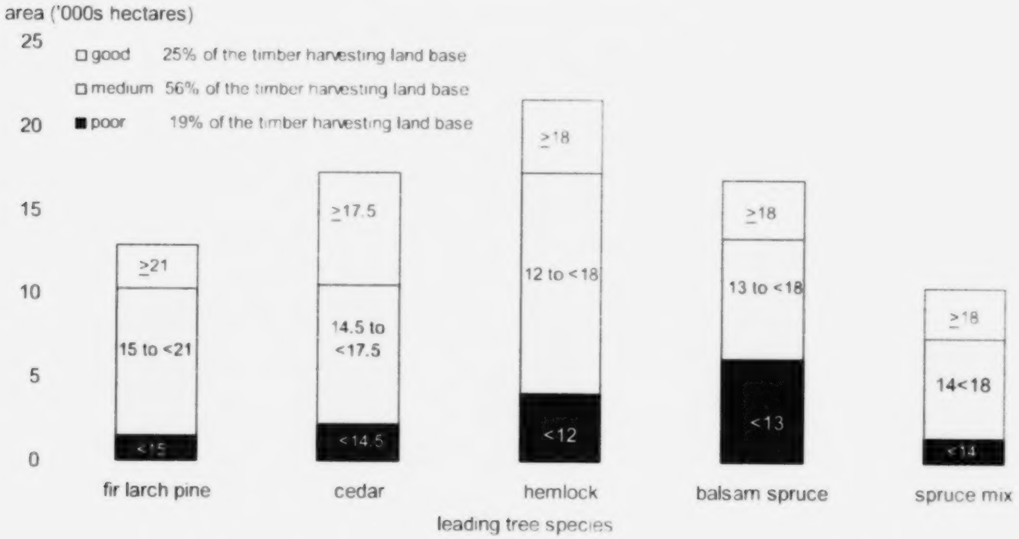

Figure 6. Area by dominant species and site productivity — Revelstoke TSA timber harvesting land base, 2004.

Site index

A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 6 depicts the distribution of site productivity of stands on the timber harvesting land base. The figure shows the composition by species and site index (SI)* group.

In the analysis, stands were grouped according to their site indices into categories of relative site productivity: good, medium, or poor. These groupings were used to project expected volumes over time for stands of similar species composition and site productivity. The site index thresholds used to group the stands varied somewhat by dominant species depending on the range observed for each species.

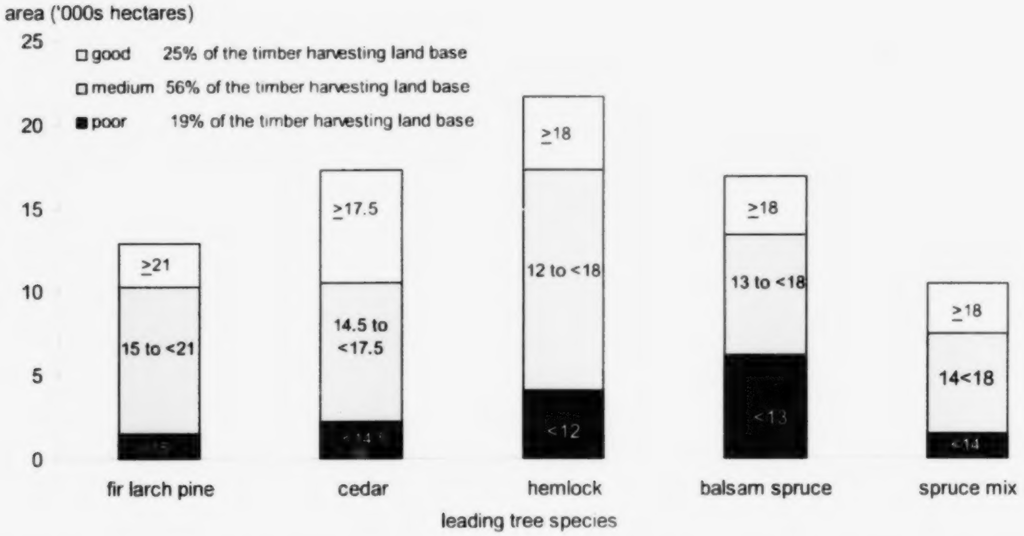

Figure 6. Area by dominant species and site productivity — Revelstoke TSA timber harvesting land base, 2004.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Table 7. Average site indices of stands on the timber harvesting land base — Revelstoke TSA, 2004.

Dominant species	Total area of stands on the timber harvesting land base (hectares)	Average area weighted site index (metres)
Fir/Larch/Pine	12 879	18.4
Cedar	17 203	16.8
Hemlock	21 636	15.0
Balsam/Spruce	16 853	14.8
Spruce mix	8 692	16.9
	77 263[a]	

(a) Not including backlog or deciduous stands.

Twenty-five per cent of the stands on the timber harvesting land base are considered to have relatively good site productivity (a site index of at least 17.5, 18 or 21 metres depending on the species). The majority of the timber harvesting land base is occupied by stands of medium site productivity, with a site index low ranging from 12 metres to 15 metres depending on the predominant species, and a high ranging from 17.5 to 21 metres. Finally, 19% of the timber harvesting land base is occupied by poor stands, with site indices of less than 12 to 15 metres, again depending on the species.

Stands with very low timber quality (not expected to be harvested under current minimum economic criteria), were excluded in the derivation of the timber harvesting land base, as were stands with a low site index. As described under Appendix A, "Description of Data Inputs and Assumptions for Timber Supply Analysis," stands with a site index of less than either 8 or 9 metres, depending on the species, were excluded.

For a specific site, only the site index of the predominant species is reported. A single site index does not fully represent the productivity of all species in mixed-species stands; however, the leading species site index is used to calculate overall averages for the TSA land base. The area-weighted average site index of all stands on the timber harvesting land base is 16 metres. The average site indices for stands on the timber harvesting land base by dominant species are shown in Table 7 above.

The average site index on the timber harvesting land base by species ranges from 18.4 metres for the fir, larch and pine stands to 14.8 metres for the balsam-spruce stands.

The site indices on the inventory file, as calculated from stand height and age data, were used in the base case of the analysis. Site index adjustments were developed during the provincial old-growth site index project. While the applicability of those adjustments to the Revelstoke TSA is uncertain, the potential timber supply implications of the adjustments were explored in a sensitivity analysis* discussed in Section 5.5.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

Figure 7 shows the current age class distribution of the stands on the Crown productive forest land base in the Revelstoke TSA. The forest outside the timber harvesting land base is comprised of those areas excluded in the derivation of the timber harvesting land base for one or more of the following reasons: they were inoperable, required as riparian buffers, considered environmentally sensitive, had too low site productivity, were covered in non-merchantable forest types or they were required to meet stand-level biodiversity* objectives.

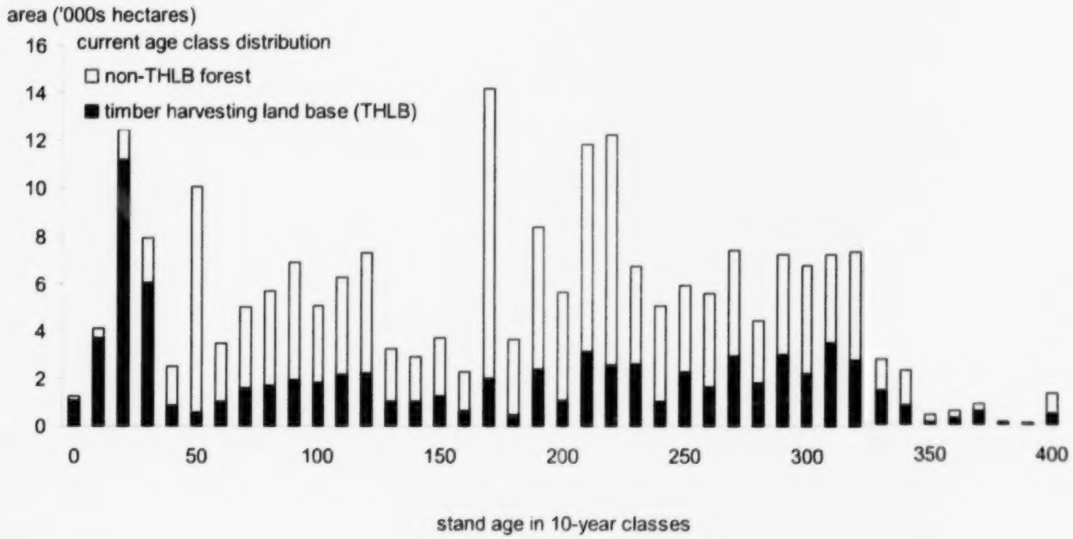

Figure 7. Current age class distribution — Revelstoke TSA forested land base, 2004.

On the timber harvesting land base, about 20% of the area is covered with stands 20 years of age or younger, 20% with stands between 21 and 100 years of age, and 32% with stands between 101 and 250 years of age. About 52% of the area is occupied by stands over 140 years of age, and 28% of the area is occupied by stands older than 250 years.

Stand-level biodiversity

A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

The age class distribution of the non-timber harvesting land base forest also affects timber supply. Although these areas do not contribute directly to timber supply, they provide old- and mature-forest attributes to meet various objectives, such as those for landscape-level biodiversity, caribou or ungulate habitat. Therefore, the age of stands on these areas can affect the quantity and pattern of the harvesting activity within the TSA.

The impact of the age class distribution of the forest outside the timber harvesting land base on timber availability is different in the Revelstoke TSA than in some other management units in the province, because the Minister's Advisory Committee recommendations guiding operations in the TSA require that landscape-level biodiversity objectives for old- and mature-forest be met on the total Crown productive forest land base both above and below the operability line (proportional representation). Therefore, not all old- and mature-stands on the non-timber harvesting land base can contribute to the retention requirements on the operable area. However, management objectives for other values, such as visual quality and ungulate habitat, relate to the entire forested area within the applicable management zone, and hence all of the non-timber harvesting land base forest can contribute.

Only one per cent of the stands on the non-timber harvesting land base are 20 years or younger, 23% are between 21 and 100 years of age, and 53% are between 101 and 250 years of age. About 67% of these stands are over 140 years of age, and 23% are older than 250 years of age.

Assessment of the age class distribution of the forests outside of the timber harvesting land base is an important factor in estimating the amount of timber harvesting land base needed to meet old-forest biodiversity requirements and other management objectives. Although they are not harvested, forests outside the timber harvesting land base are susceptible to disturbance by wind, fire, insects or disease which would affect the distribution of age classes. It is therefore important to emulate natural disturbance cycles in the non-timber harvesting land base to ensure that the overall area is not assumed to contain a higher amount of old-seral forest than would be the case in reality. This factor was accounted for in the base case, and further explored in Section 5.12, "Uncertainty in the level of disturbance outside the timber harvesting land base."

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Revelstoke TSA timber supply analysis. The variable density yield prediction (VDYP)* model developed by the Ministry of Sustainable Resource Management, Resource Information Branch, was used for estimating volumes in unmanaged stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous* managed stands. Managed stands are those currently 25 years of age or less (likely harvested over the past 25 years and subject to prompt reforestation and stocking control) and all stands harvested in the future. All stands currently older than 25 years of age, whether they had a harvesting history or not, were assumed to be unmanaged and their volumes were projected using VDYP.

Timber volume estimates* assume a specific utilization level, or set of dimensions, which establish the minimum sizes of trees and their corresponding logs that will be removed from a harvested site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific growth and yield versions of the growth and yield models used.

Volume estimation and prediction are subject to a level of imprecision, due to uncertainties in the inventories which form the basis for estimating site productivity, relatively limited experience with second-growth forests in British Columbia, and the long time frame over which forests grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," were conducted to examine the potential impacts associated with the possibility that actual timber volumes may be different from the estimates used in this analysis.

Based on the timber volume estimates made in the analysis, the current volume of the inventory on the timber harvesting land base is approximately 21.8 million cubic metres. About 20.7 million cubic metres, or 95% of the total, is contained in stands considered currently merchantable, or in other words stands older than their minimum harvestable ages (MHA)*.

Variable Density Yield Prediction model
An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Minimum harvestable age
The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).

2.3 Management practices

The availability of timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined and modelled in the timber supply analysis process. Forest practices legislation and associated regulations have guided forest management practices in the Revelstoke TSA. The focus of the timber supply review is to assess timber supply based on current management practices as implemented for the area. Current management is described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Staff in the Columbia Forest District provided descriptions for the following management practices guiding operations in the Revelstoke TSA:

- Silviculture — reforestation activities required to establish free-growing* stands of preferred and acceptable tree species. The majority of areas in the Revelstoke TSA are harvested using a clearcut harvesting* system and regenerated by planting suitable species.
- Forest health and unsalvaged losses* — volumes of timber lost to fire and insect or disease damage on the timber harvesting land base are expected to average 9219 cubic metres per year for the entire 250 year analysis horizon.
- Utilization levels — specific minimum sizes of trees, which reflect the utilized volume in the logs to be removed during harvesting.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Clearcut harvesting
A harvesting method in which most trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.

Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.

- Cutblock adjacency* and green-up* — in the Revelstoke TSA, approval of harvesting activities in a specific area is contingent on previously harvested stands reaching a desired condition, or green-up (e.g., two metres in height for stands in the integrated resource management (IRM)* area), before an adjacent stand may be harvested. The purpose of the cutblock adjacency guideline is to prevent timber harvesting from becoming overly concentrated in any one area. In the analysis, this guideline was reflected through the application of a constraint to specific zones (such as the IRM zone), that limited the amount of area covered by stands less than a specific age to a maximum of 25%. The ages were calculated to correlate to the age at which the stands reached a 2-metre inventory height, as used in the Minister's Advisory Committee timber supply impact analysis.
- Maintenance of scenic values — maintaining scenic values requires that the visible evidence of harvesting be kept within specific limits in visually sensitive areas of the Revelstoke TSA, such as the scenic highway corridor along Highway 1 and Highway 23 South. Heights at which young stands are considered greened-up in visually sensitive areas are taller than the green-up heights guiding adjacency in non-visually sensitive areas. The maximum proportion of the Crown productive forest land base in each area that could be covered by young stands not meeting visual green-up requirements (six metres in height) varies depending on the assigned visual quality objective (VQO)*, ranging from 5% in areas with retention VQOs* to 15% in areas with partial retention VQOs*. Areas with modification VQOs* were assumed to require the same level of management as the IRM portion of the timber harvesting land base (no more than 25% of the stands on the Crown productive forest land base could be less than 2 metres in height at any one time).
- Revelstoke Caribou herd habitat area — the Revelstoke TSA provides important habitat for the Revelstoke Caribou herd, and management of this habitat guides operational practices. This habitat area covers 32% of the forest and 45% of the timber harvesting land base in the TSA. Forest cover requirements designed to reflect current management practices were applied in the analysis, including minimum percentages of Crown productive forest area on slopes less than 80% to be retained in stands older than 140 years of age, and older than 250 years of age. Several sensitivity analyses were also performed to explore the timber supply implications of possible changes in the current management regime for caribou.
- Protection of environmentally sensitive areas — areas with sensitive soils or risk of avalanches have been identified, and the data delineating these areas was used to partially or entirely exclude them in the derivation of the timber harvesting land base. These assumptions reflect operational considerations around these areas.
- Deer and moose habitat — current management practices to provide for both deer and moose

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Retention VQO
Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see ***Visual quality objective****).*
Partial retention VQO
Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see ***Visual quality objective****).*
Modification VQO
Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity (see ***Visual quality objective****).*

habitat in the Revelstoke TSA were reflected in the analysis through the application of specific forest cover requirements to ensure a minimum of 40% of the Crown productive forest land base in the habitat areas was covered by stands at least 120 years of age.

- Minimum harvestable ages (MHAs) — the minimum harvestable ages reflect the length of time it takes for stands to grow to a merchantable condition, as defined using specific criteria. In the Revelstoke TSA, minimum harvestable ages were calculated using several criteria. Existing unmanaged stands were considered merchantable if they had achieved the age at which maximum mean annual increment* (CMAI) is attained, and if they had achieved the minimum stand volume criteria (200 cubic metres per hectare for stands dominated by cedar and hemlock, and 150 cubic metres per hectare for all other stands). Managed stands were considered merchantable if they had achieved the age at which 95% of the maximum mean annual increment was achieved (known as 95% CMAI), if they had met the minimum volume criteria defined above for unmanaged stands, and if in addition the largest 250 trees had achieved an minimum diameter at breast height (dbh) of 25 centimetres. The actual age at which stands are harvested may be greater than the minimum harvestable age, as the timing of harvest is influenced by many factors, such as the ages of other stands available, the green-up conditions of adjacent stands, or retention requirements to meet old- or mature-forest for landscape-level biodiversity or habitat objectives. However, in the analysis the actual age at which a stand is harvested is never less than the minimum harvestable age.
- Landscape-level biodiversity — to maintain biological diversity throughout a landscape unit*, the *Landscape Unit Planning Guide* and the Order Establishing Provincial Non-Spatial Old Growth Objectives specify targets for the proportion of the area in each biogeoclimatic variant* that should be covered by stands with old forest characteristics. Within the Revelstoke TSA, stands greater than 250 years of age are considered to meet the requirements for old forest. Draft landscape unit boundaries have been delineated in the TSA, and biodiversity emphasis options (BEO) have been identified, and these were modelled in the analysis. Specific requirements around mature forest retention and proportional representation that arose from the Minister's Advisory Committee recommendations were also reflected in the analysis.
- Minister's Advisory Committee — the recommendations from this committee guide forest management in the Revelstoke TSA, as well as the adjacent tree farm licences*. Current practices in the TSA related to the recommendations were modelled in the analysis, including specific requirements for landscape-level biodiversity, green-up, caribou, deer and moose habitat.
- Stand-level biodiversity — to assist in the maintenance of biological diversity in forest stands, wildlife tree patches (WTPs) are retained in areas after harvesting. Wildlife tree patches are portions of the original stand left unharvested to provide habitat for wildlife species dependent on the original stand condition. In the analysis for the Revelstoke TSA, retention of WTPs was modelled by applying an area reduction in the derivation of the timber harvesting land base. A proportion of each forest polygon to be retained was calculated for each biogeoclimatic variant using the assumption that 50% of the WTP requirement could be met from outside the timber harvesting land base.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

2 Information Preparation for the Timber Supply Analysis

The data package for the third timber supply review of the Revelstoke TSA was released in June 2002. In response to public input, subsequent modifications to management practices and to conditions in the TSA, some changes were made to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to reflect them in the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

The timber harvesting land base in the Revelstoke TSA is managed for specific forest cover objectives*, as described briefly in the preceding bullet points. Figure 8 depicts the percentages of the timber harvesting land base that are subject to specific forest management objectives. The total percentages in the bar chart exceed 100% because portions of the land base are managed for more than one objective simultaneously.

For example, the area managed to provide for ungulate habitat overlaps with the area managed for caribou habitat requirements.

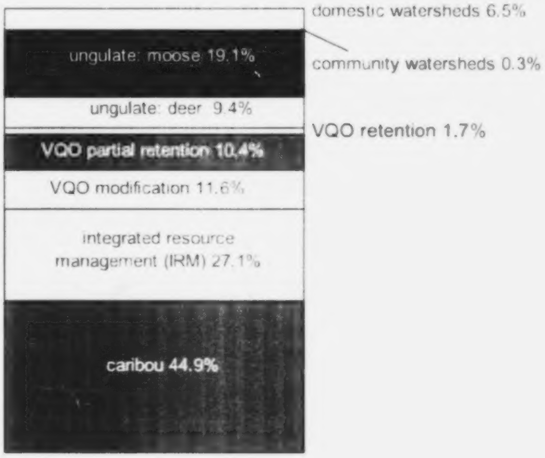

Figure 8. Timber harvesting land base by management emphasis — Revelstoke TSA, 2004.

Just under one-third of the caribou habitat area is managed for at least one other objective. About 17% of the area managed for caribou is also managed for moose; 9% is considered visually sensitive, 4% is managed for deer, and 2% is in domestic watersheds*. About 64% of the moose habitat and about 27% of the deer habitat areas are also caribou habitat. About 60% of the area managed for deer habitat is considered visually sensitive and 18% is in domestic watersheds. Area managed for domestic watersheds is primarily considered visually sensitive (87%), and 17-21% provides caribou or deer habitat.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency and Green–up****)*

While Figure 8 focuses on the timber harvesting land base, the Crown productive forest area outside the timber harvesting land base also contributes to the achievement of objectives for wildlife, visual quality and watersheds.

Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

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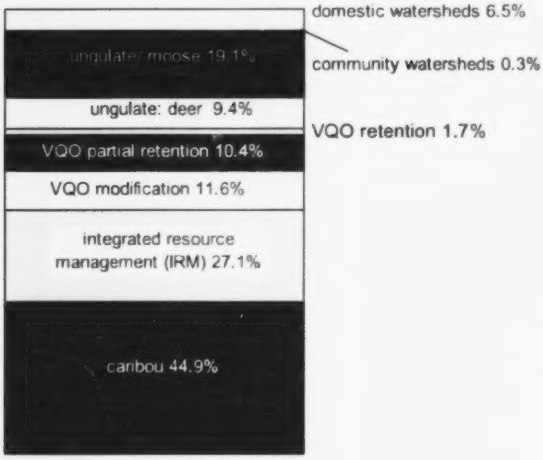

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Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

2.4 Changes since the 1998 Revelstoke TSA analysis

In this section, the major changes to the assumptions around land base and forest management since the last timber supply analysis for the Revelstoke TSA are presented.

The total area of the TSA has increased by 48 000 hectares between the 1998 and the 2004 analysis. This increase in area is as a result of several factors:

- the TSA boundaries were refined to TRIM heights of land since the previous analysis;
- two areas excluded during the previous mapping are now correctly mapped to the TSA; and
- reconciliation of the TSA and district boundaries along the southern boundary of the TSA.

These adjustments increased the size of the total TSA area, but the adjusted area did not greatly increase the size of the total Crown productive forest.

The total Crown productive forest increased by about 1350 hectares since the 1998 analysis. This increase can be attributed largely to the expiration of a number of timber licences since the previous analysis.

The operable land base was re-evaluated following the 1998 timber supply analysis. The 1997 operability line used in the 1998 analysis—based on reasonable access—was refined to incorporate criteria related to timber quality and harvesting economic conditions. As a result, a larger area was excluded as 'inoperable' in this analysis. However, the larger area described as inoperable overlapped with the Greeley Creek exclusion and many of the stands excluded as problem forest types (PFT) in the 1998 analysis. Therefore, although the area was categorized differently, in the end, approximately the same amount of area was excluded from the timber harvesting land base.

Some exclusions were applied differently in the two analyses, making it difficult to directly compare the magnitude of land base exclusions. For example, deciduous* forest types were a separate reduction in the 1998 analysis, but were largely excluded as problem forest types in the 2004 analysis. A small portion of deciduous stands were retained in the timber harvesting land base in the 2004 analysis and assumed to be treated and regenerated to coniferous-leading stands.

A specific reduction was applied to account for the retention of wildlife tree patches to provide for stand-level biodiversity requirements in the 2004 analysis.

The long-term timber harvesting land base is approximately 14 500 hectares larger in this analysis. This is primarily a result of two factors:

- environmentally sensitive area reductions were 8000 hectares smaller in the 2004 analysis, and
- reductions to account for the construction of future roads, trails and landings were 1500 hectares smaller based on a review of silvicultural records.

The size of the area managed as caribou habitat has increased since the 1998 analysis. The forest cover constraints are applied to 72 200 hectares of productive Crown productive forest, up from 63 500 hectares previously. Therefore the percentage of the total Crown productive forest managed for caribou habitat has increased from 29% to 32%. On the timber harvesting land base, caribou management requirements now apply to 35 000 hectares, up from 33 000 hectares in 1998. However, the percentage of the timber harvesting land base modelled as caribou habitat has decreased from 49% to 45% due to the overall increase in the size of the timber harvesting land base since 1998.

The size of the area modelled as ungulate (deer and moose) habitat has also increased since the 1998 analysis. The change has resulted due to correction of the habitat linework used in the 1998 analysis. The habitat now covers 30 000 hectares of total Crown productive forest, as compared to 16 600 hectares in 1998. The area of timber harvesting land base managed for ungulates has increased to 22 300 hectares from 10 000 hectares.

Deciduous

Deciduous trees shed their leaves annually and commonly have broad-leaves.

2 Information Preparation for the Timber Supply Analysis

Current harvesting in the TSA is directed towards cedar- and spruce-leading stands. Therefore, harvesting priority was placed on these stands for the first three decades in the analysis.

Forest Development Plan information was incorporated to identify current category A cutblocks* in the TSA. A priority was placed on harvesting of these stands for the first decade of the analysis.

Natural disturbance outside of the timber harvesting land base was modelled based on disturbance return information from the *Biodiversity Guidebook* as well as local knowledge. More discussion on the modelling of natural disturbance can be found in the text after Figure 15 in Section 4, "Results" as well as in Section 5, "Timber Supply Sensitivity Analyses."

The Minister's Advisory Committee recommendations were fully reflected in the 2004 analysis.

In summary, the timber harvesting land base has increased in size by 15%, and some of the modelling assumptions have changed since the 1998 analysis. Given the extent of the changes, it is difficult to make direct comparisons between this and the previous analysis. Each timber supply analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at that time. As noted in the introductory section of this report, there is a level of uncertainty surrounding information used in analyses, and forest management objectives change over time. This is one of the primary reasons that the *Forest Act* requires the chief forester to review the timber supply and AAC for each TSA periodically.

Any changes to the land base or management assumptions* that occur or become effective after the completion of this timber supply analysis, but before the AAC determination, will be presented to the chief forester for consideration during the AAC determination, if sufficient information is available.

Cutblock
A specific area, with defined boundaries, authorized for harvest.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Revelstoke TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (the Forest Service Simulator (FSSIM) version 4.2) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (a collection of stands) could be managed to obtain a harvest forecast* (the supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report. However, the information, including inventory and harvest levels were assessed for 400 years, and remain constant throughout that time.

Similar to other timber supply models, FSSIM assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify that no more than a certain maximum percentage of the forest can be younger than a specified green-up age or that a minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates the examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict the options for future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not intended to be taken as recommendations of any particular AAC.

The analysis primarily provides forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time under specific management regimes. Although this information gives field staff limited guidance in the design of operational activities such as harvesting block location or silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Revelstoke TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Revelstoke TSA, and should not be viewed in isolation of the sensitivity analyses.

Section 2.4, "Changes since the 1998 Revelstoke TSA analysis," provides an overview of the main changes to the land base and management assumptions since the last analysis. As noted in that section, any comparison between this and the last analysis should be made with recognition of the extent and nature of those changes. As stated previously, each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, a primary reason for the requirement under the *Forest Act* for the chief forester to periodically review the timber supply and AAC is to account for any changes in management, information and knowledge.

4.1 Base case harvest forecast

The base case harvest forecast represents current management in the Revelstoke TSA, as described by the set of assumptions outlined in the sections of Appendix A of this report. Figure 9 shows the base case harvest forecast for the Revelstoke TSA. The initial harvest level of 230 000 cubic metres per year presented in the base case is the same as the current AAC in the Revelstoke TSA. The base case shows that an annual harvest level of 230 000 cubic metres can be maintained for two decades. The harvest level must then begin a series of declines: 10% over each of the next three decades, then a 2% decline to a mid-term level of 165 000 cubic metres per year that is held for nine decades before increasing by 3% to the long-term harvest level* of 170 500 cubic metres per year.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

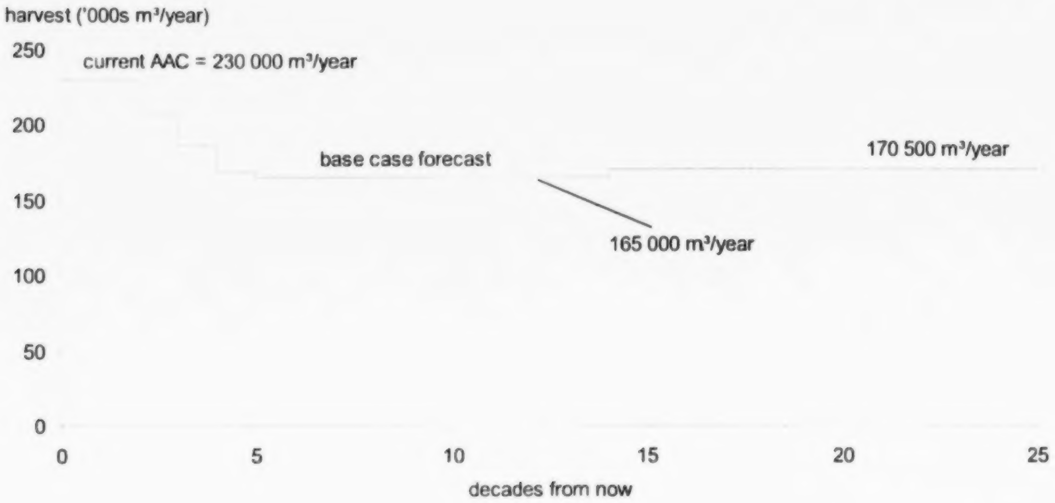

Figure 9. Base case harvest forecast — Revelstoke TSA, 2004.

Unsalvaged losses due to natural forces such as insects, wind and fire on the timber harvesting land base in the Revelstoke TSA are estimated to be 9219 cubic metres per year for the entire analysis horizon. These unsalvaged losses have been deducted from all harvest forecasts shown in this report.

4 Results

The harvest forecast for the Revelstoke TSA depends in the short- and medium-term on the amount of timber growing stock* currently existing on the timber harvesting land base. Figure 10 shows a projection of timber inventory volumes over time that corresponds to the base case harvest forecast. The total growing stock on the timber harvesting land base declines over the first six decades by 22% from 21.5 million cubic metres to 16.7 million cubic metres, as the older existing mature stands are harvested and replaced by younger second-growth stands. However, from that point the total growing stock increases again to about 19 million cubic metres. In the figure below, it appears that the growing stock continues to increase over time. However, it does flatten out over the long term; the level fluctuates slightly between 18.7 and 19 million cubic metres into the long term (400 years).

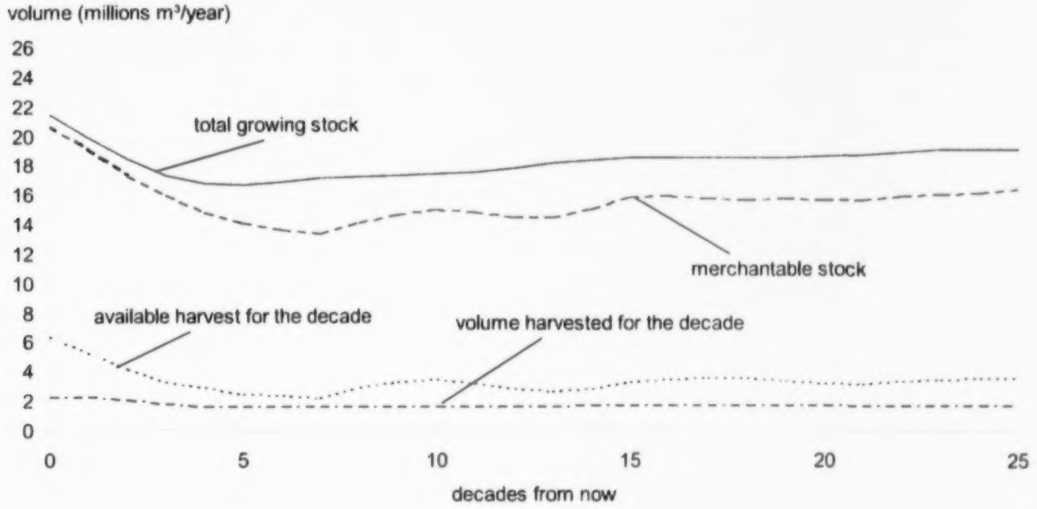

Figure 10. Total, merchantable and available growing stocks — Revelstoke TSA, 2004.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

At the start of the analysis horizon, about 20.7 million cubic metres, or 96% of the total growing stock, is contained in stands currently considered to be merchantable, (that is, older than their minimum harvestable ages). The merchantable growing stock declines from 20.7 million cubic metres at the start of the analysis horizon, to a low of 13.4 million cubic metres in the 7th decade. It very gradually increases over time in conjunction with the total growing stock, and averages about 15.6 million cubic metres over the long term.

Although a stand may be older than its merchantable age, it may not be available for harvest because retention of the stand is required to satisfy other resource requirements, such as maintenance of scenic values, biological diversity, or wildlife habitat. The 'available harvest for the decade' line on the figure above describes the maximum harvest level that could be attained if all management objectives are met while ignoring the stability of future harvest flow. For example, the 1st decade available volume* is simply the maximum harvest in that period. The 2nd decade available volume is the maximum harvest given that the base case harvest occurred in the 1st decade. Availability in the 3rd decade is the maximum harvest given that the base case levels were achieved in decades 1 and 2, and so on.

The volume of timber available for harvest in the first decade, while satisfying all the forest cover constraints imposed in this analysis, is about 6.4 million cubic metres. Available timber volume then declines to about 2.2 million cubic metres in the 8th decade. It then increases again, and thereafter averages about 3.3 million cubic metres to the end of the analysis horizon.

Also shown in Figure 10 is the volume of timber harvested in the base case. Initially there is a larger difference between the volume harvested under the base case assumptions and the volume theoretically available for harvest, but this difference declines over time until on average, the volume available for harvest is about twice the level of the base case harvest. The larger gap in the short term between the volume available for harvest and that actually harvested illustrates that in the Revelstoke TSA harvest flow choices over the next few decades are related more to the need to meter out the growing stock over time, rather than constraints on harvests to achieve other forest objectives.

The base case long-term harvest level of 170 500 cubic metres per year is the harvest rate that can be achieved while maintaining the total timber growing stock on the timber harvesting land base at a steady level, on average, over the long term. A constant level of growing stock indicates that timber harvesting could continue at the corresponding harvest level in perpetuity. A continually increasing level of growing stock would indicate that the timber is being harvested below the productive capability of the land within the context of forest management objectives (that is, the absolute maximum productivity may not be achieved since stands are held beyond the age of maximum productivity to meet objectives for visual quality, habitat, etc.). A continually declining level of growing stock would signify that the timber is being harvested at a rate above the productive capability of the land.

Available volume
The portion of total inventory volumes that is available for harvesting after all management constraints on timber harvesting have been considered, including definition of the timber harvesting land base, age of tree merchantability, deferrals, and any other priorities or constraints on timber harvesting.

4 Results

Figure 11 shows the transition of harvesting from existing unmanaged stands to managed stands, and the proportion that each type of stand contributes to the base case forecast over time. For the first six decades the harvest level is entirely dependent on volume from existing unmanaged stands. The harvest level then becomes gradually dependent on contributions from managed stands. Existing old and thrifty stands continue, however, to contribute at least 10% to the harvest forecast, even after the long-term harvest level is reached in decade 14. As late as the 18th decade, the original old and thrifty stands support 20% of the harvest forecast. After this time, harvests are projected to be supported primarily by managed stands, and original unmanaged stands provide only about 6% of the timber supply. The need to meet specific old and mature forest objectives for such values as biodiversity and caribou habitat in the Revelstoke TSA restrict the harvest of old and thrifty stands.

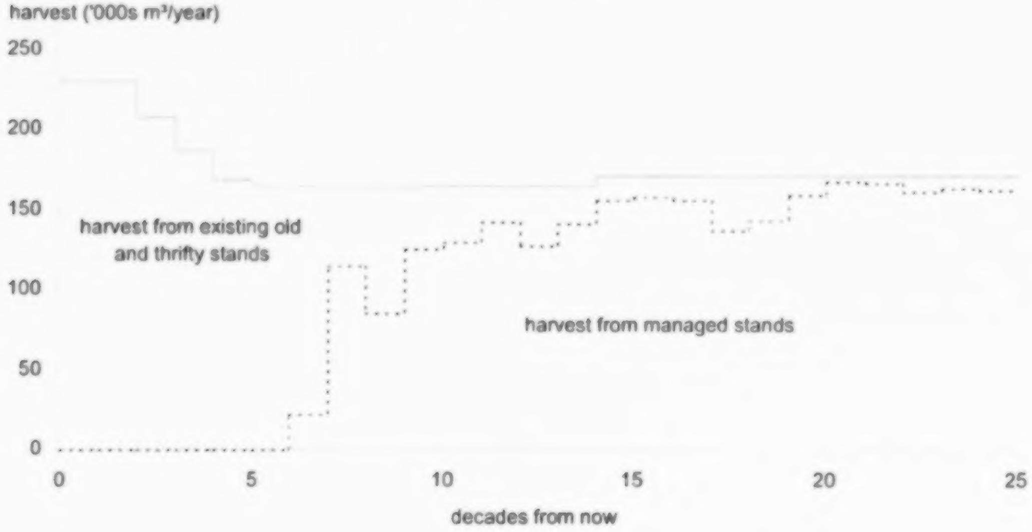

Figure 11. Harvest contribution from existing and managed stands — Revelstoke TSA, 2004.

4.2 Average age, area, and volume harvested

Figure 12 illustrates the change in the average harvest age of stands under the assumptions in the base case harvest forecast, weighted by volume. As mentioned above, the harvest for the first six decades comes entirely from existing unmanaged stands, and therefore the average age of the stands harvested over this time is 269 years, well above the minimum harvestable ages of these stands. As the contribution from managed stands gradually begins to support the harvest level, the average age of stands harvested declines to about 146 years in the mid term. The age of stands at harvest averages 127 years between the achievement of the long-term harvest level after decade 14 and decade 25.

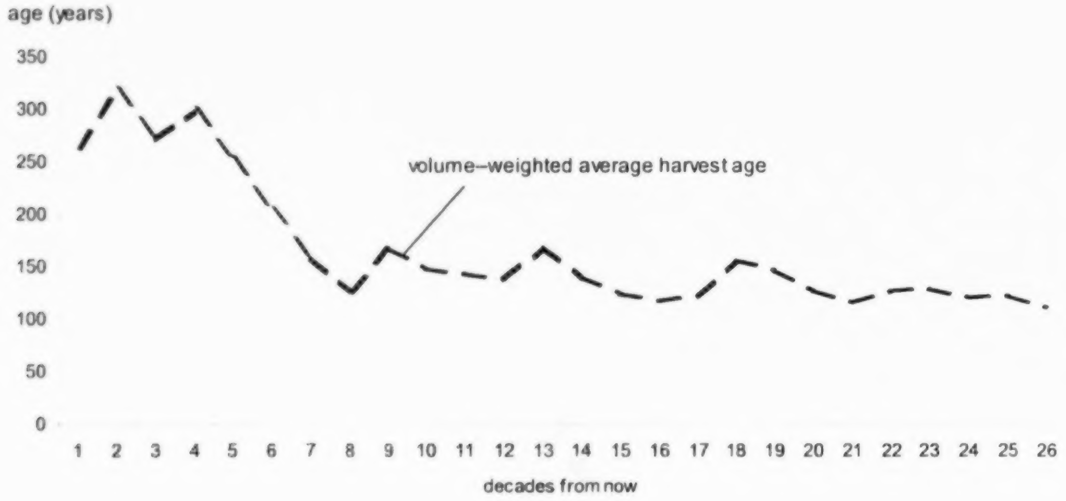

Figure 12. Average age of stands harvested over time — Revelstoke TSA base case, 2004.

For comparison, the average area-weighted age to achieve culmination of mean annual increment (CMAI) for stands in the Revelstoke TSA timber harvesting land base is 111 years at the beginning of the analysis horizon. Due to changes in the stand composition of the timber harvesting land over time due to harvesting and regeneration, the average age at CMAI is projected to be 116 years in 15 decades. Culmination of mean annual increment was used in conjunction with the age to achieve the minimum stand volume for determining minimum harvestable ages for existing unmanaged stands. For the majority of stands, with the exception of old and thrifty cedar stands on poor sites, the age to achieve CMAI was the older of the two ages, and determined the minimum harvestable ages.

The average age at which 95% of CMAI is achieved — the primary criterion in establishing minimum harvestable ages for managed stands, given it took longer for stands to achieve 95% of CMAI than the minimum dbh or volume criteria — is 99 years over the entire horizon. For all future managed stands and the majority of existing managed stands in the Revelstoke TSA, minimum harvestable ages were set at these ages. In the modelling, stands are on average harvested at ages older than their minimum harvestable ages over the entire analysis horizon.

4 Results

Figure 13 shows the average volume per hectare harvested over time under the assumptions in the base case harvest forecast. For the first six decades, with harvest levels entirely supported by unmanaged stands, the average volume harvested is 456 cubic metres per hectare (ranging from 539 to 373 cubic metres per hectare). Existing unmanaged stands support the majority of the harvest until decade 10, and the average volume per hectare harvested over this time (the first ten decades) is 415 cubic metres. After this time, when the harvest level is primarily supported by managed stands, the average volume per hectare harvested is 384 cubic metres. This volume remains the average for the remainder of the analysis horizon (400 years).

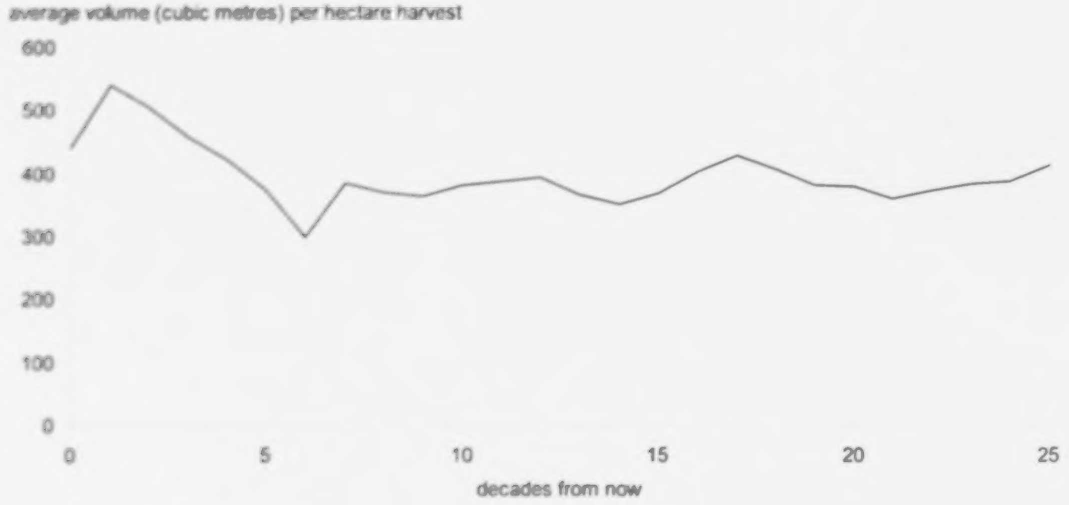

Figure 13. Average volume per hectare harvested over time — Revelstoke TSA base case, 2004.

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Figure 14 shows the average annual area harvested over time on the total timber harvesting land base for the Revelstoke TSA. The figure also illustrates the area harvest contribution of caribou habitat areas. The total average annual area harvested is initially 544 hectares, but averages 438 hectares over the next five decades. In the seventh decade, it increases to 584 hectares per year, the highest level of the entire analysis horizon, as the harvest level abruptly becomes dependent on the lower volume managed stands, and the average age of stands harvested drops by 55 years (see Figure 12). Thereafter, it varies slightly but averages 466 hectares per year. Over the full analysis horizon the average annual area harvested is approximately 468 hectares, or about 0.6% of the timber harvesting land base. At the harvest levels indicated in the base case, it would theoretically take 167 years to cycle through one harvest of all stands on the entire timber harvesting land base. However, this does not occur in practice because stands on some sites are retained in perpetuity while other areas may be harvested more than once over time.

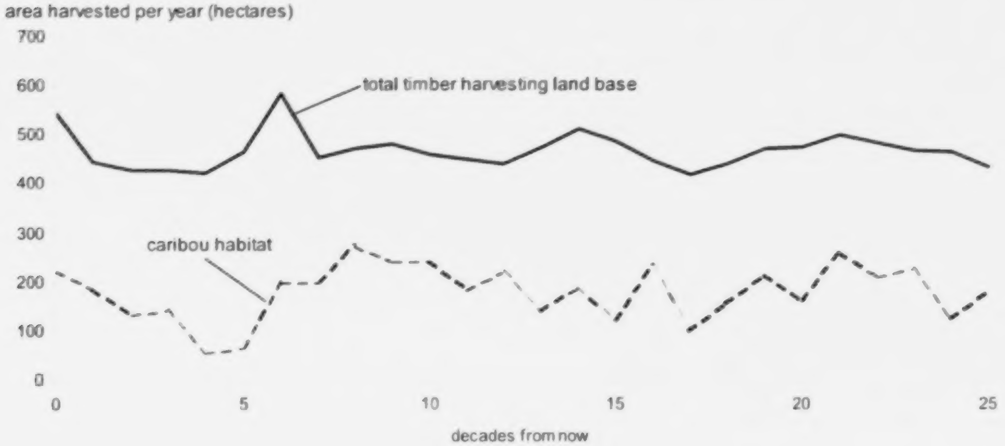

Figure 14. Average annual area harvested over time for the Revelstoke TSA, 2004.

Table 8 shows the contribution to the overall harvest projection of areas within the four main management emphasis areas (integrated resource management, visual quality, moose and deer, and caribou). Percentages are shown by both area and volume, and these are consistent in most cases. The table highlights the substantial contributions of areas being managed for non-timber values. Over all time frames, caribou habitat areas, are projected to contribute about 40% to the harvest by both area and volume. Moose and deer habitat provide about 17% of the harvest over the short term, and from 22 to 25% over the mid- and long-terms. Areas with visual quality objectives are projected to provide about 6% of the volume harvest (9% by area) in the short term, and 16 to 19% over the longer term.

In particular, caribou habitat provides a large portion of the harvest, and management requirements in those areas are an important determinant of timber supply. The impacts of caribou management requirements on timber supply will be discussed further in Section 5.8, "Uncertainty in the assumptions for managing caribou habitat."

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Table 8. Harvest contributions (area and volume) for each management emphasis group — Revelstoke TSA, 2004

Time frame		IRM	Visual quality	Moose & deer habitat	Caribou habitat
Short term (1-20 years)	Area	39.1%	8.9%	17.4%	41.8%
	Volume	40.9%	6.2%	17.3%	42.7%
Mid term (21-140 years)	Area	39.4%	17.0%	22.1%	37.6%
	Volume	39.8%	16.1%	22.5%	38.0%
Long term (141-250 years)	Area	37.4%	17.4%	23.2%	38.8%
	Volume	35.6%	18.7%	24.9%	39.3%

4.3 Age class profile over time

Figure 15 shows the change in age composition of the productive forest land base for the Revelstoke TSA over time, under the assumptions in the base case harvest forecast.

The productive forest land base in the Revelstoke TSA is approximately 222 800 hectares in size. The timber harvesting land base comprises about 78 000 hectares or 35% of this area.

The 65% of the productive forest outside of the timber harvesting land base does not contribute directly to timber supply but is still an important factor in achieving objectives for landscape-level biodiversity, wildlife habitat, and other values in the TSA.

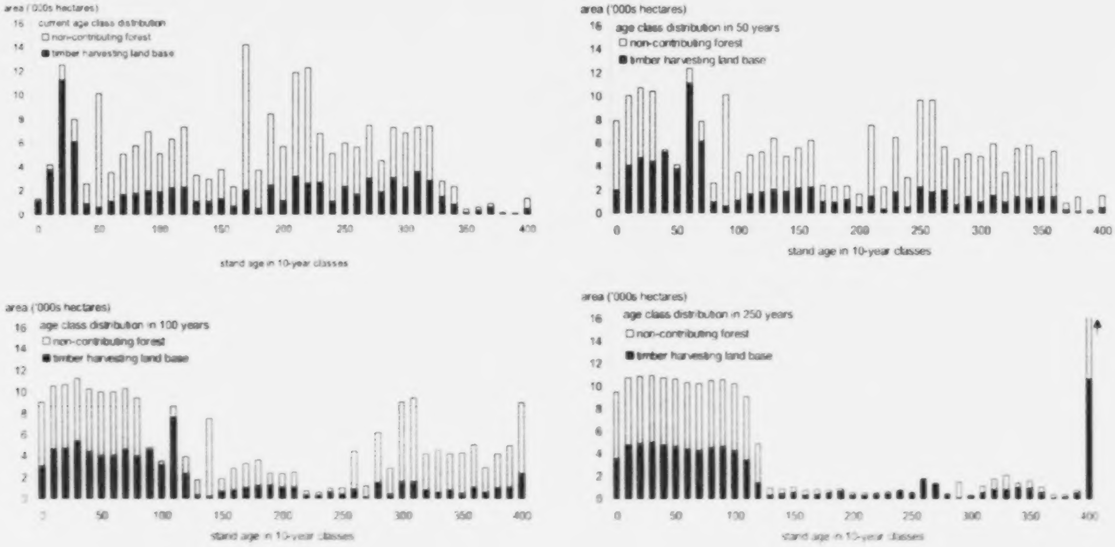

Figure 15. Changes in age composition on the productive land base over time — Revelstoke TSA base case, 2004.

4 Results

The initial distribution of stands on the timber harvesting land base of the TSA is indicative of the harvesting and silviculture history in the area. About 29% of stands are less than 40 years of age, with about half of these stands between 11 and 20 years of age. Only 14% is between 40 years of age and the average minimum harvestable age for stands of about 110 years. The majority of stands, about 57%, on the timber harvesting land base are at or above their minimum harvestable ages at the start of the analysis horizon. About 90% of these stands are older than 140 years of age, and half of the stands are over 250 years of age. Overall, 28% of the timber harvesting land base is covered in stands currently over 250 years of age.

Over time, the distribution of stand ages on the timber harvesting land base changes. The proportion of stands over their minimum harvestable ages drops from its current value of 57% to 32% in 100 years and 33% in 250 years. The amount of merchantable stands (i.e., over minimum harvestable age) over time is not constraining, however, since only about 0.6% of the timber harvesting land base is harvested annually, as indicated in the previous figure. The stands younger than their minimum harvestable age are converted into a fairly uniform distribution of ages.

Relative to the initial age distribution, the proportion of stands over 140 years of age decreases over time, to about 30% of the timber harvesting land base after 100 years. Thereafter, the proportion older than 140 years is maintained primarily in order to meet objectives for ungulate and caribou habitat. For the same reasons, stands older than 250 years of age comprise an average of 25% of the timber harvesting land base over time even after 250 years. A substantial portion of the timber harvesting land base is not harvested over the analysis horizon.

The non-timber harvesting land base has had less disturbance than the timber harvesting land base, and thus the stands there are on average older. At the start of the analysis horizon, only 4% of the stands are less than 40 years of age. Nearly 67% are older than 140 years of age, and 23% are older than 250 years of age.

In the timber harvesting land base it was assumed that disturbance would be dominated by harvesting, including potential salvage of timber damaged in natural disturbances. However, disturbances also occur in forests outside the timber harvesting land base. Since non-timber harvesting land base forest contributes to forest cover requirements, modelling of natural disturbance was required to appropriately estimate the contribution of those forests to forest retention objectives. The level of disturbance was estimated to reflect the expected natural disturbance affecting the distribution and quantity of old and mature stands. In addition, a maximum percentage of area was permitted to be covered in stands greater than 250 years of age based on disturbance return interval information from the *Biodiversity Guidebook* (page 92). These percentages ranged from 49% in the ESSF biogeoclimatic zone to 37% and 29% in NDT 1 and NDT 2 of the ICH biogeoclimatic zone.

The age class distribution of the non-timber harvesting land base forest does not initially resemble the predicted distribution in the *Biodiversity Guidebook*. For instance, the proportion of area covered with stands over 250 years of age in the non-timber harvesting land base forest is less at the start of the analysis horizon than suggested by the *Guidebook*. The distribution of ages changes over time under the assumptions used in the base case. The proportion of stands over 250 years of age increases from 26% of the forested land base initially to the 44% expected on average in the *Guidebook* by six decades from now. It remains relatively constant at that level over time. The proportion of stands over 140 years of age declines from 68% to 46%, and remains constant thereafter.

Although the proportions of area in stands over 140 and over 250 years of age remain constant after reaching the *Guidebook* levels, the distribution of areas within the older age classes—in particular, over 400 years of age (see Figure 15)—is more reflective of the modelling technique than what is expected to occur in nature. For the purposes of the analysis, it was important to ensure that the overall proportion of the non-timber harvesting land base forest in stands over 250 years of age reflected what might occur in reality. How these stands were distributed within the age classes beyond this age was not relevant in the modelling since any stand over 250 years old would meet the old-seral requirements, and the volumes in stands outside the timber harvesting land base were not relevant to the analysis outcome. Therefore, an unrealistically high proportion of stands was projected to be over 400 years of age, whereas in reality these stands would likely be more evenly distributed between 250 and 400 years of age. Because of the model set-up, modelled disturbance occurred primarily in stands between 100 and 250 years of age throughout the analysis horizon. The age of stands disturbed in the non-timber harvesting land base forest averaged 200 years for the first 11 decades, 150 years for the next 10 decades, and 120 years thereafter. Consequently, the proportion of area in stands between 110 and 250 years of age declines substantially over the analysis horizon.

The increase over time in the area of forest over 250 years of age outside the timber harvesting land base, as seen in Figure 15, may seem counterintuitive since the expectation would normally be that natural disturbances would decrease or perhaps maintain the area of old forest over time. First, it should be noted that the disturbance regime, including the target area above 250 years of age, was modelled after both the *Biodiversity Guidebook* and local observations. Second, while the area over 250 years of age increased over the analysis horizon, the area over 140 years old in the non-timber harvesting land base decreased (from 68% initially to 46%).

Other approaches to modelling natural disturbances in the non-timber harvesting land base forest are possible. The assumptions and modelling of the natural disturbance for the Revelstoke TSA are discussed further under Section 5.12, "Uncertainty in the level of disturbance outside the timber harvesting land base."

5 Timber Supply Sensitivity Analyses

The best information available on forest inventories and management practices was used to analyse the timber supply implications of the current management regime in the Revelstoke TSA. However, forest management is complicated since it must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, so that the decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest may change, or how our management activities will affect the forest.

One important means of addressing this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important means of addressing uncertainty is to assess how values of interest, (for this analysis, timber supply), could change if any of the information used in the analysis to describe current knowledge and practices is not accurate. Sensitivity analysis is one method used to evaluate how uncertainty could affect the forecast of timber supply under the current management regime. Sensitivity analysis can highlight that fairly small adjustments in some variables could have large effects on timber supply projections, or conversely that significant changes in other variables, representing a high level of uncertainty, could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in one time frame than in another. For example, some factors affect the short-term timber supply but have very little effect in the long term. In addition, sensitivity analysis can highlight priorities for collecting information for use in future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a reliable basis for decisions, or whether a high level of uncertainty about an important variable suggests a more cautious approach to decision-making.

In this section, the results of a number of sensitivity analyses are discussed. Sensitivity analyses are intended primarily to assess the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case. The short term refers to the first 20 years of the harvest forecast, the mid term is the period between 21 and 140 years from the start of the analysis horizon, and the long term is the period after 140 years, the point at which the long-term steady harvest level is reached in the base case. Impacts to timber supply that are discussed in the text are measured over these time periods (e.g., a short-term impact is assessed over the first twenty years).

5.1 Alternative harvest flows

The base case harvest forecast shown in Figure 9 was developed under a specific set of assumptions. Some of these assumptions guide the development of all harvest flow projections, such as ensuring a stable forest inventory over the long term. The set of assumptions specific to the base case include the following: an initial harvest level set at the level of the current allowable annual cut; maintaining this level for as long as possible before beginning to decline, and without negatively impacting the ability to achieve the long-term harvest level; setting the long-term harvest level no lower than the level possible under a non-declining even-flow forecast; and, ensuring that any declines do not exceed 10% per decade.

5 Timber Supply Sensitivity Analyses

Figure 16 compares three possible alternative forecasts to the base case forecast. All assumptions related to land base, growth and yield and forest management remain constant in all of the alternative forecasts.

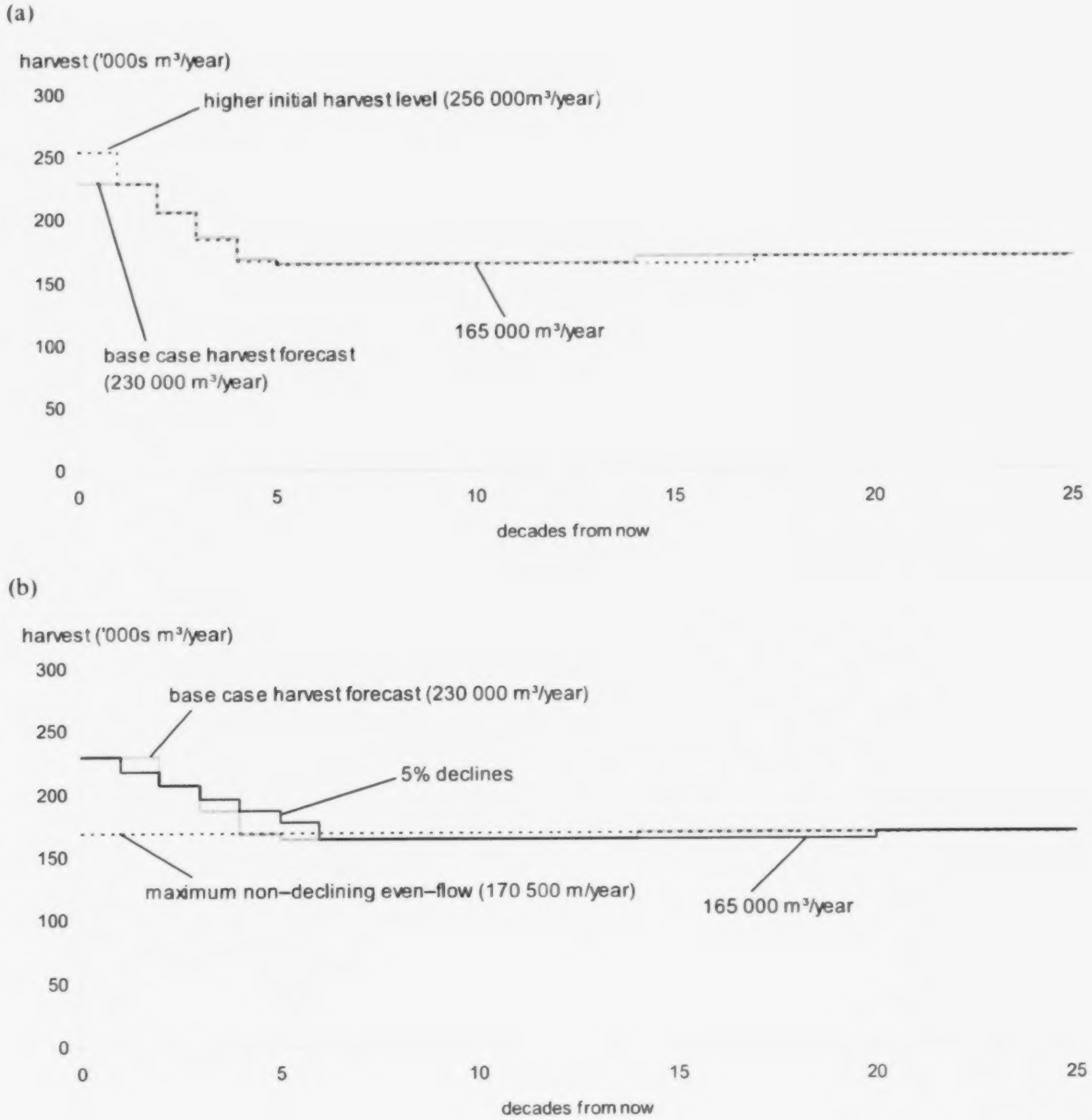

Figure 16. Alternative harvest forecasts (a) higher initial harvest level; (b) slower rate of decline (5%) and non-declining even-flow — Revelstoke TSA, 2004.

5 Timber Supply Sensitivity Analyses

Maximum non-declining even-flow harvest level

- The maximum possible non-declining even-flow of timber supply was used as a reference to determine the long-term harvest level in the base case.
- A non-declining even-flow harvest level of 170 500 cubic metres per year can be maintained in the TSA throughout the analysis horizon. This harvest level is about 26% lower than the initial harvest level in the base case.
- Under this scenario, the total harvest volume over the 250-year analysis horizon is slightly lower (2.6%) than that resulting from the base case.
- The concept of non-declining even-flow allows for the possibility of the harvest level increasing over time, but not decreasing. However, a long-term level higher than the short- and mid-term levels shown was not possible.

Higher initial harvest level

- It is possible to increase the initial harvest level for one decade to 256 000 cubic metres per year, a level 11% higher than the initial harvest level in the base case and the current AAC.
- After the higher initial level, this alternative follows essentially the same declines as the base case. The same mid-term level is reached in the same decade as the base case; however, the harvest must remain at that level for an additional three decades relative to in the base case before the long-term harvest level can be achieved.
- The long-term harvest level is the same as that in the base case.
- Over the entire analysis horizon, the total volume harvested is essentially the same (0.2% higher) as that resulting from the base case.

One decade at current harvest level

- An alternative harvest flow was performed in which the level of the current AAC was maintained for only one decade before beginning a similar set of declines to the base case forecast.
- This harvest flow is not depicted on Figure 16. The mid- and long-term levels were the same as in the base case. However, in this scenario, the mid-term harvest level was achieved one decade sooner than in the base case, and the long-term level was achieved after only 11 decades, three decades sooner than in the base case.
- The total volume harvested over the analysis horizon in this alternative was slightly lower (1.1%) than in the base case harvest forecast.

Five per cent declines harvest level

- One additional harvest flow, with a series of 5% declines commencing after one decade at the current AAC, was assessed.
- The mid- and long-term levels were the same as in the base case harvest forecast. However, the mid-term harvest level was attained one decade later than in the base case. The long-term level was not attained until the end of the 20th decade, or six decades later than in the base case.
- The total volume harvested under this alternative was the same as that resulting in the base case harvest forecast.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the land base available for timber harvesting can result from factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions.

The current timber harvesting land base estimated for this analysis is about 15% larger than that in the last timber supply analysis for the Revelstoke TSA. A comparison of the assumptions for the two analyses has not identified any particular concerns regarding the assumptions used in this analysis to reflect the current land base and management regime.

5 Timber Supply Sensitivity Analyses

Although no specific concerns were identified regarding the derivation of the timber harvesting land base, an understanding of the implications to the base case timber supply projection of changes in the size of the timber harvesting land base may be useful if new information becomes available prior to the AAC determination. In the Revelstoke TSA, two potential sources of uncertainty have been noted: one relates to a possible future land base withdrawal, and the other relates to the merchantability of stands comprised primarily of hemlock species. Sensitivity analyses were conducted to explore the implications of these uncertainties. Assumptions regarding the levels of natural disturbance in the non-contributing land base were not adjusted from those in the base case for these sensitivity analyses.

Two general sensitivity analyses were conducted around the size of the timber harvesting land base. The implication of reducing the size of the timber harvesting land base by 13% was assessed; this percentage was selected as it would bring the current timber harvesting land base to about the size assumed in the 1998 analysis. The implication of increasing the size of the timber harvesting land base by 10% was also assessed.

Reducing the size of the timber harvesting land base by 13%

- The reduction was applied as a 13% exclusion of area from all stand types and sites on the timber harvesting land base. The area excluded from the timber harvesting land base was added to the non-timber harvesting land base, so that overall the size of the Crown productive forest land base did not change.
- The analysis shows that as expected, timber supply is sensitive across all time horizons to a reduced land base (Figure 17).
- The short-term timber supply under this scenario is 14.2% lower than in the base case, and the mid term is 15.1% lower. The long-term harvest level is 13.2% lower than in the base case.

5 Timber Supply Sensitivity Analyses

Increasing the size of the timber harvesting land base by 10%

- Area in all stand types and sites on the timber harvesting land base was increased by 10%. An equivalent area was excluded from the area outside the timber harvesting land base, so that overall the size of the productive forest land base did not change.
- The results of this sensitivity analysis indicated that the base case initial harvest level could be maintained for an additional two decades before beginning to decline. Higher mid- and long-term levels were possible. The overall impact over the mid-term was 8.5%. The long-term harvest level was 11.1% higher. A higher initial level was not attempted.

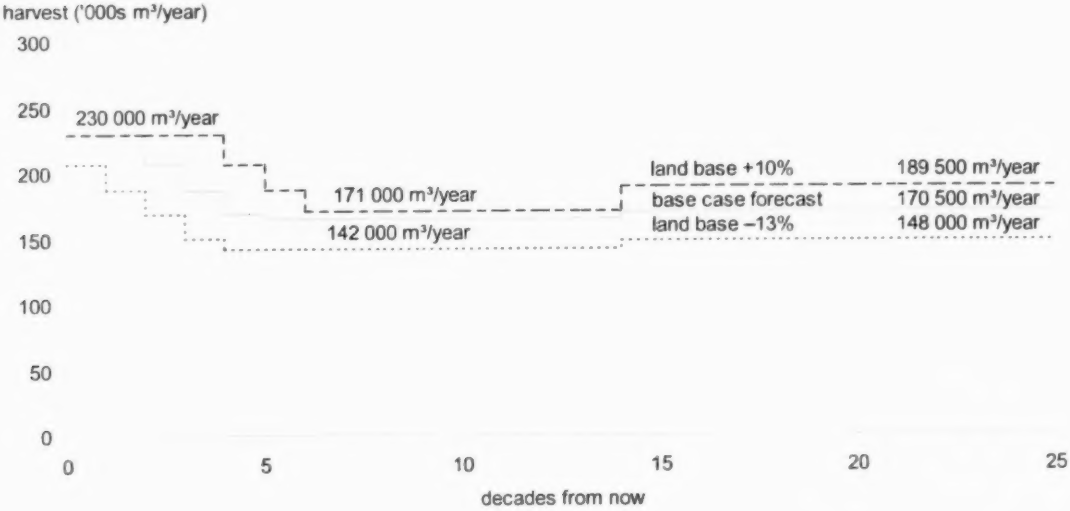

Figure 17. Reducing or increasing the size of the timber harvesting land base — Revelstoke TSA, 2004.

5 Timber Supply Sensitivity Analyses

Mount Mackenzie Ski Resort Expansion Proposal

- The Revelstoke TSA's mountainous terrain is of high value for winter recreation, including skiing. Currently, a proposal exists to expand the Mount MacKenzie Resort Area, which would impact the size of the productive forest and the timber harvesting land base in the TSA.
- This area comprises about 4780 hectares of the TSA. About 4000 hectares of this area was estimated to be productive forest, with about two-thirds of the area contained in the Akolkolex (R3) landscape unit, and the remaining one-third in the Illecillewaet (R20) landscape unit. The timber harvesting land base impacted is estimated to be about 1960 hectares, or 2.5%. A sensitivity analysis was conducted to approximate the timber supply impacts of excluding an equivalent amount of area from the timber harvesting land base in these two landscape units (the area was assumed to be still available to contribute to seral objectives). Figure 18 below shows one possible timber supply forecast. The short-term projection is 2.6% lower than in the base case, the mid-term level 2.9% lower and the long-term level 2.6% lower.
- The forecast shown in Figure 18 shows the implications of immediately reducing timber supply to account for the possible land base withdrawal. As with most forecasts in this analysis, different harvest flow patterns would be possible. In this case, it would also be possible to maintain the base case initial harvest level for two decades before declining to a mid-term harvest level 5.5% below that of the base case (harvest forecast not shown). The long-term harvest level would be 2.5% below the base case level.

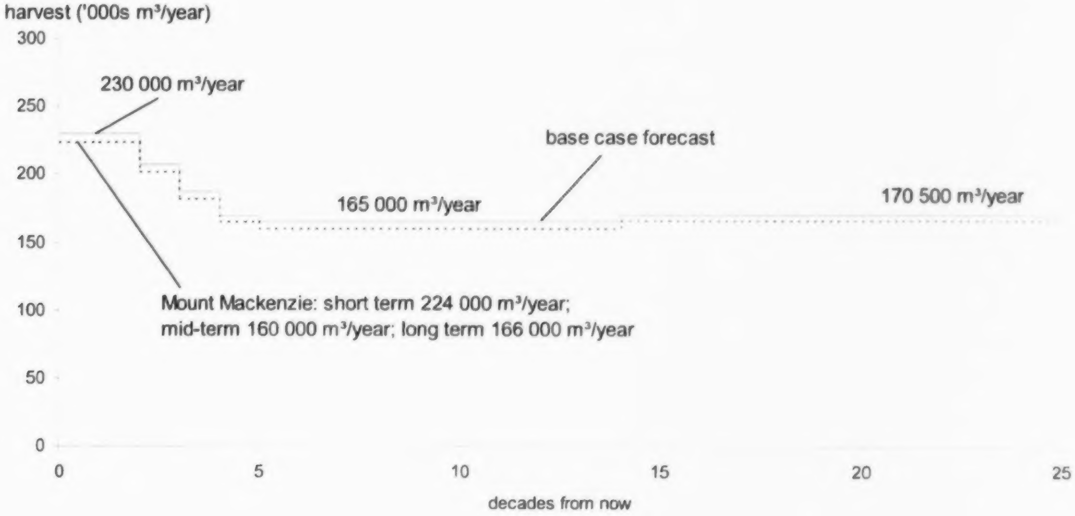

Figure 18. The effect on the harvest forecast of excluding the Mount MacKenzie resort proposal area from the timber harvesting land base — Revelstoke TSA, 2004.

Stands with a high proportion of hemlock stems

District staff have noted that there are concerns about the merchantability of stands with high proportions of hemlock species.

- In particular, the merchantability of stands comprised of more than 59% hemlock species, or stands comprised of more than 79% hemlock species is subject to uncertainty. The timber harvesting land base in the Revelstoke TSA is comprised of about 14 900 hectares of stands with more than 59% hemlock stems by volume, about 4500 hectares of which is in stands with more than 79% hemlock stems by volume. These stands form significant proportions of the timber harvesting land base in the Revelstoke TSA; 18.8% and 5.7%, respectively.
- To evaluate the implications to timber supply if all or some of these high-proportion hemlock stands are not in fact merchantable to harvest, sensitivity analyses were performed. For the sensitivity analysis, the old hemlock stands were excluded from the timber harvesting land base, and added to the forest outside the timber harvesting land base.

If stands comprised of more than 59% hemlock species were unmerchantable

- These stands comprise nearly 19% of the timber harvesting land base. In the sensitivity analysis, each of the analysis units (AU)* for old and thrifty hemlock-leading stands (analysis units 031, 032, 033, 131, 132, and 133) was reduced by the amount of area expected to be occupied by stands with more than 59% hemlock stems. The harvest forecast resulting is shown in Figure 19.
- Timber supply is affected across the entire analysis horizon. The initial harvest level in the base case cannot be attained. The maximum initial harvest level possible with these stands excluded from the timber harvesting land base is 27% below the base case initial level, or 169 000 cubic metres per year. This level can be maintained for only one decade before two 10% declines are required, followed by a smaller decline to a mid-term harvest level of 131 000 cubic metres per year. The maximum long-term harvest level attainable is 138 000 cubic metres per year.
- Overall, short-term timber supply is reduced by 30%, mid-term timber supply by 23% and long-term timber supply by 19.5%.
- The long-term impact to timber supply is consistent with the proportion of area that these stands contribute to the timber harvesting land base. However, in the short- to mid-term, the volume from the hemlock stands supports a much greater proportion of the harvest. The total area of hemlock-leading unmanaged stands is 20 026 hectares at the start of the analysis horizon, or 25% of the timber harvesting land base. However, in the first decade, 44% of the harvested volume comes from hemlock-leading stands. Over the first five decades, an average of 30% of the volume harvested in the base case comes from these stands. In addition, hemlock stems tend to have higher than average volumes at similar reference ages than cedar, fir or balsam stems; therefore, stands dominated by hemlock species would likely have higher than average volumes. For these reasons, the impact to short- and mid-term timber supply is greater than the proportion of the timber harvesting land base excluded. Over the entire analysis horizon, 21% less volume is harvested than in the base case.

If stands comprised of more than 79% hemlock species were unmerchantable

- These stands comprise 5.7% of the timber harvesting land base. The area was excluded in the same manner as described above. The initial harvest level attainable in this sensitivity analysis is 10% less than that in the base case. Over the next two decades, the harvest level must decline in two steps of 10% and then two smaller declines before reaching a mid-term harvest level 3.6% lower than in the base case.

Analysis unit
A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.

- Overall, short-term timber supply is reduced by 14.3% and mid-term timber supply (21-140 years from now) by 6.3%, relative to the base case timber supply, for the same reasons as mentioned above. The decrease in the long-term harvest level is proportional to the reduction in the size of the timber harvesting land base by the exclusion of these stands (5.6%).

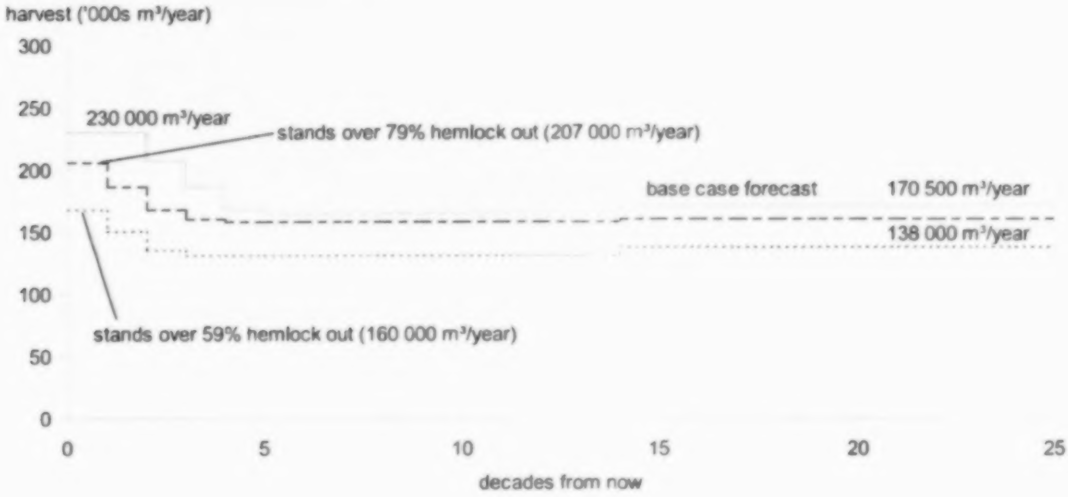

Figure 19. The effect on the harvest forecast of excluding high-proportion hemlock stands from the timber harvesting land base — Revelstoke TSA, 2004.

5.3 Uncertainty in the volume estimates for unmanaged stands

Existing, unmanaged stands in the Revelstoke TSA are those stands older than 25 years of age at the start of the analysis horizon. These stands comprise 75% of the initial timber harvesting land base, and support the entire harvest in the base case until the end of the sixth decade.

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Timber volumes are normally accurate when averaged over large areas, but may not reflect actual volumes within individual stands. Uncertainty may also arise in the estimates of volume lost to decay in older trees, of waste and breakage during harvest, and of the utilization levels practiced during harvesting.

Two sensitivity analyses were conducted to assess the implications to the timber supply projected in the base case if there is uncertainty in the volume estimates for existing unmanaged stands.

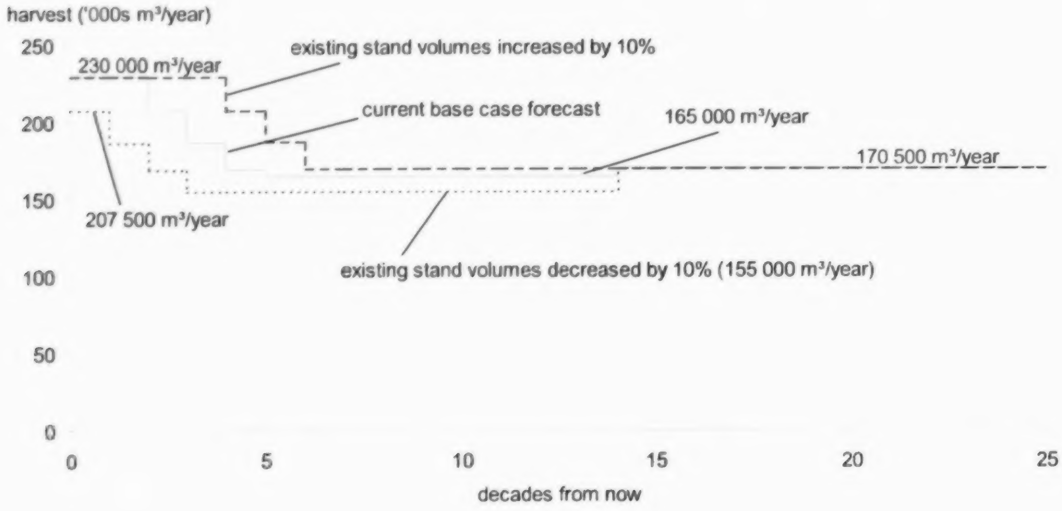

Figure 20. The effect on the harvest forecast of increasing or decreasing volume estimates for existing unmanaged stands — Revelstoke TSA, 2004.

If existing unmanaged stand volumes are 10% lower than assumed in the base case

- The base case initial harvest level cannot be attained without causing future disruption in timber supply. A harvest of 207 500 cubic metres per year, or 10% lower than the initial harvest level in the base case, can be held for one decade before beginning to decline.
- After one decade, the harvest level declines in a series of 10% reductions to a mid-term level of 155 000 cubic metres per year, 6% lower than the mid-term level in the base case.
- Overall, short-term timber supply is 14.2% lower than in the base case, and mid-term timber supply is 8.5% lower than in the base case.
- The long-term harvest level is the same as in the base case, and achieved in the same decade.

If existing unmanaged stand volumes are 10% higher than assumed in base case

- The same initial harvest level as in the base case can be held for two additional decades before beginning to decline. Although an initial harvest level at the level of the current AAC was selected in this scenario, a higher level would have been possible.
- The mid-term harvest level achieved after six decades is the same as the long-term harvest level in the base case.
- Overall, mid-term timber supply is 8.3% higher than that in the base case. The long-term harvest level is the same as in the base case.

5.4 Uncertainty in the volume estimates for managed stands

Managed stands are those stands 25 years of age or younger at the start of the analysis horizon, and all stands regenerated in the future. These stands comprise 25% of the timber harvesting land base initially, but comprise 71% of the timber harvesting land base by the time the long-term harvest level is reached in the 15th decade. Timber supply begins to depend on the volume from managed stands after the sixth decade, and becomes primarily dependent on this volume in the eighth decade.

Uncertainty in volume estimates for managed stands can exist for the same reasons as listed for unmanaged stand yields (inaccuracies in the forest inventory or in the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. To assess the implications to timber supply in the Revelstoke TSA, sensitivity analyses were conducted.

Figure 21 below shows the effect on the base case harvest forecast if managed stand volumes were assumed to be under- or overestimated by 10%.

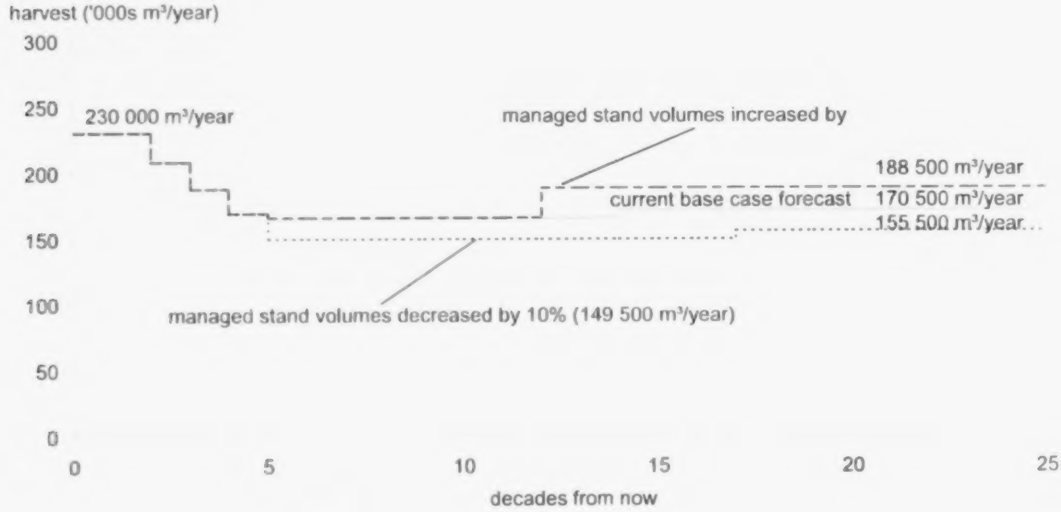

Figure 21. The effect on the harvest forecast of increasing or decreasing volume estimates for managed stands — Revelstoke TSA, 2004.

If managed stand volumes were 10% lower than assumed in the base case

- The harvest forecast is the same as that of the base case for the first five decades, and hence the short-term timber supply is unaffected.
- After the fifth decade, the harvest level declines to 149 500 cubic metres per year, a level 6.9% below that in the base case. This mid-term harvest level is maintained until decade 17 before it climbs to the long-term harvest level.
- Overall, mid-term timber supply is 6.8% lower than in the base case.
- The long-term harvest level is 155 500 cubic metres per year, or 9.7% lower than the base case level.

If managed stand volumes were 10% higher than assumed in the base case

- The harvest forecast is the same as the base case for the first twelve decades. After that point, it climbs to a long-term harvest level of 188 500 cubic metres per year.
- Short-term timber supply is unaffected relative to the base case. Mid-term timber supply is 2.5% higher, and long-term timber supply is 10.6% higher than in the base case.

The implications to timber supply of the application of future genetic gain values to managed stands

- Seedlings from improved or class A seed are planted in all areas for which the seed is available in the Revelstoke TSA. Class A seed has specific genetic gain, or genetic worth values, expressed as a percentage of expected volume increase at an index age (80 years for white spruce, and 60 years for lodgepole pine and Douglas-fir in the interior, and for all coastal species). The current genetic worth value of 3.8% for spruce was applied to all future regenerated stands in the base case.
- Estimates for future values for genetic gain for the spruce and Douglas-fir seed planted in the Revelstoke TSA are also available. Future genetic gain values are 7.8% for spruce and 18.8% for Douglas-fir. If all stands on the timber harvesting land base were assumed to be harvested over the analysis horizon and regenerate to managed stands with the expected regenerated species composition (a theoretical premise only, because as indicated earlier 18% of the original unmanaged stands are never harvested in the modelling), then 47% of the timber harvesting land base would eventually be comprised of spruce stems and 21% comprised of Douglas-fir stems.
- A sensitivity analysis was conducted to assess the implications to timber supply if the future genetic gain values were applicable to all Douglas-fir and spruce seedlings planted in stands from ten years into the analysis horizon onward. In addition to the stand yield estimates, adjustments were also made to minimum harvestable ages and to the estimated ages to reach green-up in the sensitivity analysis.

5 Timber Supply Sensitivity Analyses

- The results of the sensitivity analysis are shown in Figure 22 below. Short- and mid-term timber supply are unaffected by the increased volumes in spruce and Douglas-fir stems in managed stands that result from the application of the future genetic worth values. The genetic worth values begin to have an impact in decade 14, at the point at which the timber supply climbs to the long-term level in the base case. The future genetic worth results in a 3.5% increase in the long-term harvest level.

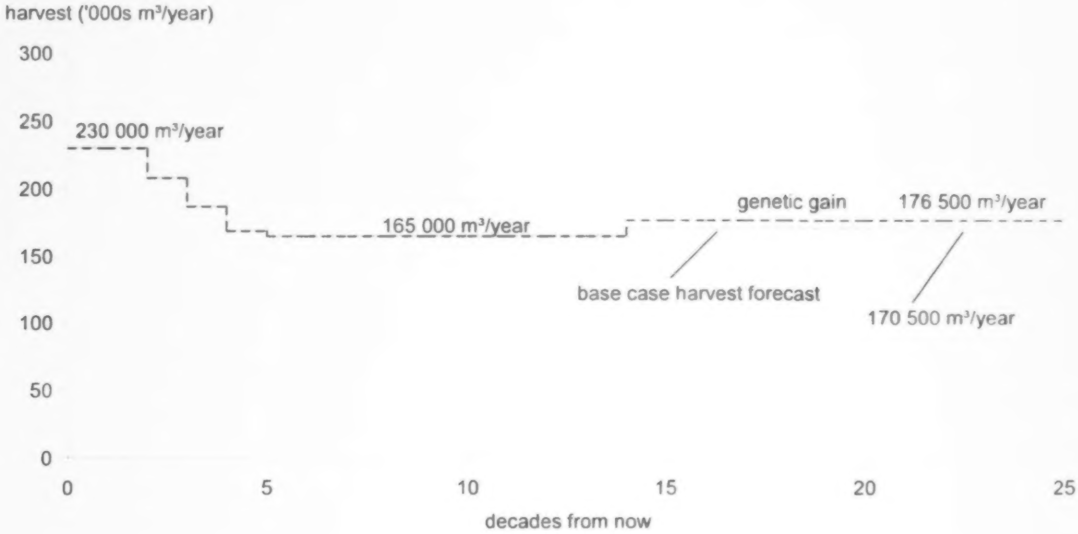

Figure 22. The effect on the harvest forecast of applying future values for genetic gain — Revelstoke TSA, 2004.

- The expected genetic gains and the proportions of the timber harvesting land base expected to be regenerated to Douglas-fir or spruce would imply about 6% more total volume, if all stands were harvested close to their minimum harvestable ages, and regenerated under the theoretical premise mentioned above. Over the period between decades 15 and 25, stands are harvested on average at 102 years of age, or very close to their minimum harvestable ages (area-weighted average of 99 years for managed stands). However, 18% of the timber harvesting land base is never harvested, but rather retained in order to meet seral objectives. In addition, a proportion of existing stands continues to contribute to timber supply into the long term, leading to a smaller increase in the long-term harvest level than would be expected given the volume increase indicated by the genetic worth values.
- Overall, the results of all three of the above sensitivity analyses show that any uncertainty in managed stand volume estimates has no impact on the short-term timber supply for the Revelstoke TSA. There is adequate volume available in existing stands in the short- to mid-term to support the base case harvest forecast. As seen in Figure 11, managed stands do not begin to contribute volume to the base case harvest until the end of the sixth decade. The percentage increase or decrease in managed stand volumes does not result in a fully proportional impact to long-term timber supply because volumes from existing unmanaged stands continue to contribute a small proportion of volume to the long-term timber supply (as much as 20% in the eighteenth decade, and 6% into the long term).

5.5 Uncertainty in site productivity estimates

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years, (particularly stands less than 15 years) the growth history of trees has not yet been long enough to give accurate measurements of site productivity using conventional site index tools (site curves) and inventory estimates of height and age.

Site productivity estimates derived for older stands may also be incorrect as stands are well past the age of maximum height growth and have often been affected by disease, insects and top damage as they reach an advanced age. As a result, measurements from these trees can lead to underestimation of the growing potential of the site. If the site productivity estimates from these older stands are used to estimate the growth potential of young replacement stands, volume growth could also be underestimated.

No localized site productivity studies have been conducted in the Revelstoke TSA. Available province-wide studies were used to assess the implications to timber supply if the site productivity in old-growth stands in the Revelstoke TSA has been underestimated.

For stands not covered by localized site index adjustment equations, the results of province-wide research that estimated productivity of sites currently occupied by old-growth stands are used as an indication of the level of uncertainty in the site productivity estimates. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are as follows:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands, and adjacent logged and regenerated stands of the same productivity. Site indices was estimated for both stands and comparisons were made. Results are available for Douglas-fir, lodgepole pine, and interior spruce stands.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study was obtained from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these two studies are of interest in the Revelstoke TSA since stands older than 140 years comprise 52% of the timber harvesting land base.

To test the sensitivity of the base case harvest forecast to the uncertainty in site productivity estimates, two sensitivity analyses were performed.

Impacts of using paired-plot study site productivity estimates for sites currently occupied by old-growth spruce-leading stands

The results of the paired-plot study indicate that the site indices calculated from the existing old-growth spruce stands underestimate the potential productivity of those sites after harvesting and regeneration.

Estimates for the managed stand volumes for those analysis units (AUs) affected by the changes in estimated future productivity were recalculated based on average adjusted site productivity. Green-up and minimum harvestable ages were also recalculated.

The results are depicted in Figure 23 below. Short- and mid-term timber supply are unaffected by the paired-plot adjustments to old-growth spruce-leading stands. In the 14th decade, when the base case harvest forecast climbs to the long-term level, the site productivity adjustments result in a 2.6% increase in the long-term harvest level, to 175 000 cubic metres per year.

Impacts of using veteran study site productivity estimates for all sites currently occupied by old growth

In the second sensitivity analysis, the OGSI adjustments suggested by the veteran study were used to adjust the productivity of all sites currently occupied by old-growth stands in the Revelstoke TSA. These results are also depicted in the figure below. Again, in this sensitivity analysis, short-term timber supply is unaffected. Mid-term timber supply is 6.7% greater than in the base case, with a harvest level of 179 000 cubic metres per year beginning in the fifth decade. The long-term harvest level is 203 000 cubic metres per year, 19.1% greater than that in the base case.

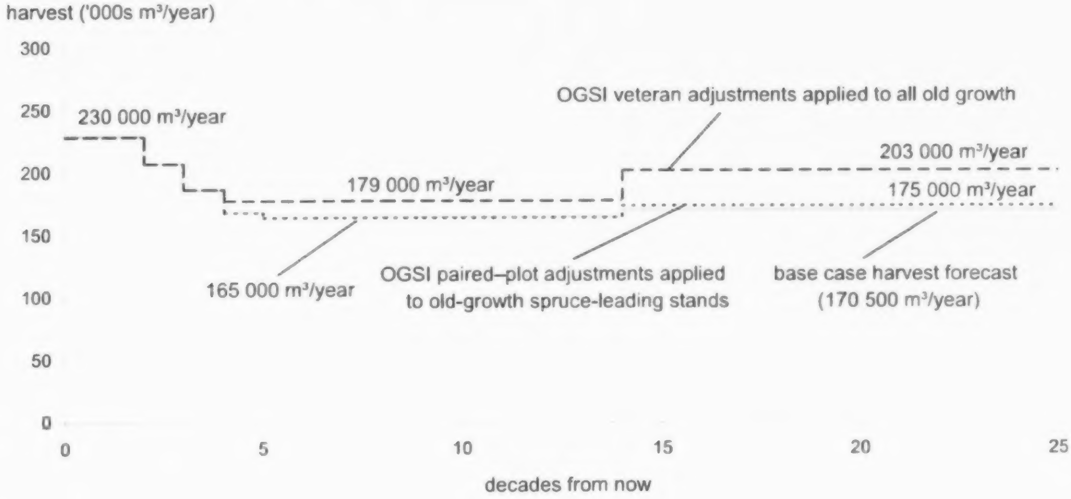

Figure 23. Harvest forecast if the site productivity adjustments suggested by OGSI studies were appropriate to stands over 140 years of age — Revelstoke TSA, 2004.

5.6 Uncertainty in the estimates for minimum harvestable ages

Minimum harvestable ages are an estimate of the time needed for stands to reach a merchantable condition. They affect the amount of time over which the harvest of existing stands must be rationed while regenerating stands grow to a merchantable age. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, existing unmanaged stands were considered merchantable at the older age of the following: the age to achieve a specified minimum stand volume, and the age at which the culmination of mean annual increment was achieved. Managed stands were considered merchantable at the age at which they attained all of three criteria, as follows: a specific minimum volume; a minimum average diameter at breast height for the largest 250 trees in the stand of 25 centimetres; and 95% of the culmination of mean annual increment. In almost all cases, the amount of time it took for stands to achieve 95% of the culmination of mean annual increment was greater than the time to achieve the other criteria, and therefore defined the minimum harvestable age. See Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," for the minimum harvestable ages applied in this analysis.

In the short term, the average area-weighted minimum harvestable age for all stands across the Revelstoke TSA is 107 years, while culmination of MAI occurs on average at 111 years of age. Stands were harvested on average at 251 years of age, or much greater than the minimum harvestable ages. In the long term (measured at the start of the 15th decade), the average minimum harvestable age for all stands is 102 years *versus* 116 years for culmination of MAI. Stands were harvested on average at 118 years of age, or very close to the culmination of MAI.

Two sensitivity analyses were conducted to assess the implications to timber supply of changing the criteria used to establish the minimum harvestable ages for either unmanaged or managed stands.

Adjusting the minimum harvestable ages for unmanaged stands

- In this sensitivity analysis, the minimum harvestable ages for unmanaged stands was set at the age at which 95% of the culmination of mean annual increment is achieved.
- The results, shown in Figure 24, indicate that timber supply is completely unaffected by adjustments to the minimum harvestable ages for unmanaged stands. These results are a function of the fact that stands are harvested at ages older than their minimum harvestable ages over the time for which the harvest from existing stands supports the base case harvest forecast.

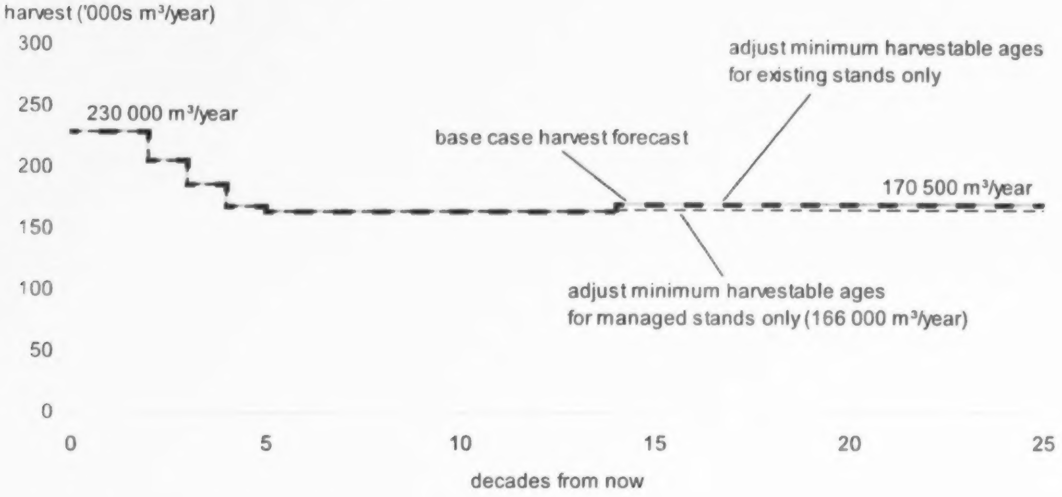

Figure 24. The effect on the harvest forecast of modifying assumptions used to derive minimum harvestable ages for unmanaged or managed stands — Revelstoke TSA, 2004.

Adjusting the minimum harvestable ages for managed stands

- In this sensitivity analysis, the minimum harvestable ages for managed stands were adjusted to be based on only the minimum volume and minimum dbh criteria. Using these two criteria alone results in ages that are younger than the ages at which 95% culmination of mean annual increment is attained, and therefore further from the ages of maximum average volume production than the minimum ages used in the base case. The results of the sensitivity analysis, then, are predictable. Short- and mid-term timber supply are unaffected, but the long-term harvest level attainable is 166 000 cubic metres per year, or 2.6% lower than the long-term harvest level attainable in the base case. Harvesting stands at ages further below the age of maximizing volume reduces timber supply in the long term.

5.7 Uncertainty in the application of landscape-level biodiversity objectives

The conservation of biodiversity is an essential component of sustainable forest use. In the Revelstoke TSA, the Revelstoke Minister's Advisory Committee (MAC) recommendations guide management to achieve landscape-level biodiversity objectives, and were reflected in the base case. While the forest cover requirements in the MAC recommendations are based on the *Landscape Unit Planning Guide (LUPG)* and the Order Establishing Provincial Non-Spatial Old Growth Objectives (old-growth order), the application of the MAC recommendations differs from the guidance provided in those two documents.

The differences are: the need for proportional representation (meeting of the old- and mature-seral requirements on the total Crown productive forest land base both above and below the operability line); the requirement for both mature- and old-seral objectives to be met even in low BEO areas; and the requirement for old-seral objectives to be met immediately in low BEO areas.

One of the objectives of the MAC was to maximize the spatial overlap of areas managed for important values to help minimize timber supply impacts. The plan is a result of five years of work by members of the public and government staff. The team members agreed that the plan as a package achieves a fair balance of risks among all resources and resource users. To date, forest licensees have been voluntarily abiding by the plan.

Draft landscape unit boundaries and biodiversity emphasis options (BEOs) for the Revelstoke TSA guide current practice and were used in the base case.

The requirements for old- and mature-seral retention were applied by assigned BEO to areas at the biogeoclimatic variant level within each landscape unit.

While the approach used in the base case represents current practices in the Revelstoke TSA, there is uncertainty about how the recommendations under the Minister's Advisory Committee affect timber supply. To explore the implications of the various aspects applied in the base case, sensitivity analyses were performed.

Proportional representation not applied

- The results are shown in Figure 25, below. The base case initial harvest level could be maintained for one additional decade before beginning to decline. The subsequent two harvest levels could each be maintained for two decades before declining to the base case mid-term level. It would have been possible to achieve a higher initial harvest level than the current AAC, however this was not attempted. Rather, the increase in timber supply was allocated to the mid-term to increase the stability of the forecast.
- Timber supply was most affected over the mid-term, being 5.3% higher than in the base case due to higher supply in the 3rd through 7th decades.
- A long-term level of 175 000 cubic metres per year, or 2.6% higher than the base case level could be attained, but is reached 5 decades later than in the base case, meaning that long-term timber supply measured between 140 and 250 years from now is 0.5% higher than in the base case.

Turn off mature-seral retention requirements

- Under the MAC strategy recommendations, mature-seral forest objectives are required to be met not only in intermediate and high BEO areas, but also in low BEOs. In this sensitivity analysis, the requirement to achieve mature-seral forest objectives was turned off in all areas.
- The results, which are not shown in Figure 25, indicate that timber supply is not sensitive to the requirements for mature forest modelled in the base case. The base case harvest forecast was unaffected.

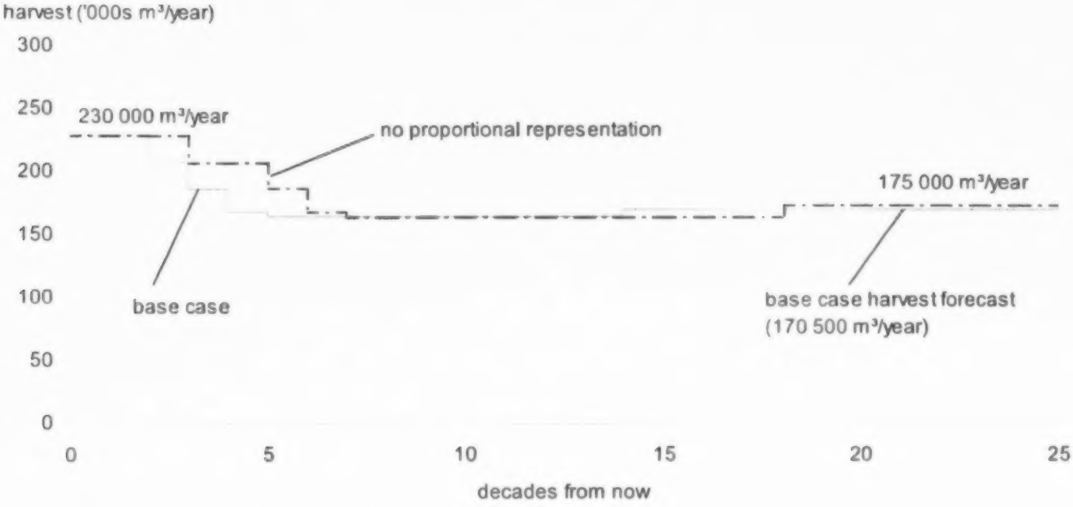

Figure 25. The effect on the harvest forecast of not requiring proportional representation in management for landscape-level biodiversity — Revelstoke TSA, 2004.

Allow phase-in of old-seral retention requirements in low BEO areas

- The MAC recommendations require that old-seral objectives be met immediately in low BEO areas in the Revelstoke TSA. In most other areas in the province, old-seral objectives are phased in over three rotations in areas with a low BEO, such that one-third of the retention requirement must be met immediately, two-thirds met after one rotation (70 years from the start of the analysis horizon) and the full requirement met after two rotations (140 years from the start of the analysis horizon).
- Figure 26 displays the results of phasing in old-seral requirements in areas with low BEO. The projected harvest for the fist 20 years is unaffected, but the decline to the mid-term level is more gradual. The harvest declines in two 20-year steps to the same mid-term harvest level as in the base case, which is reached two decades later than in the base case. Overall, mid-term timber supply is 3.2% greater than in the base case. The long-term level is 0.3% higher than in the base case but is reached two decades later (hence, cumulative long-term supply is 0.4% less than in the base case).

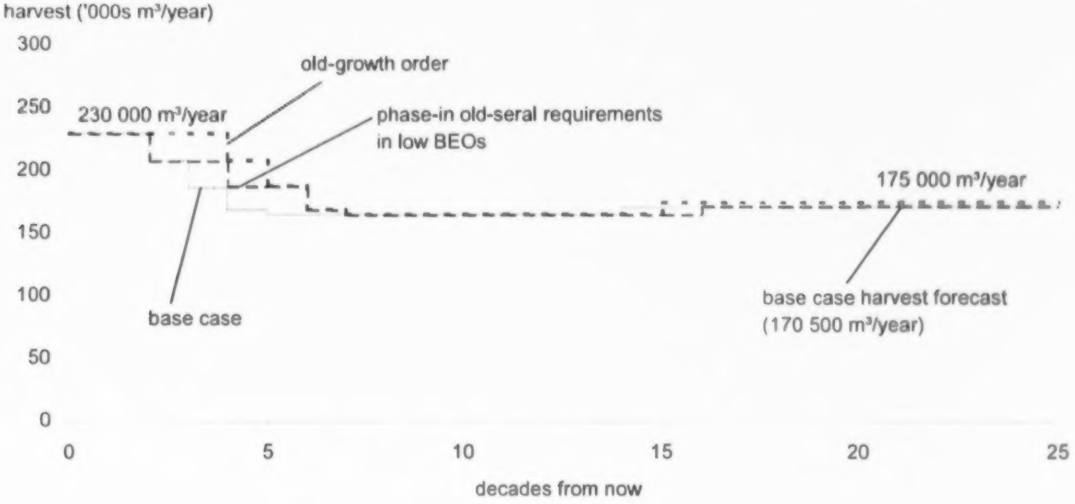

Figure 26. The effect on the harvest forecast of modifying the landscape-level biodiversity requirements — Revelstoke TSA, 2004.

Combination of the three above modifications to landscape-level biodiversity requirements (old-growth order)

- Together, the combination of the above three modifications to the modelling of landscape-level biodiversity (removal of requirements for proportional representation and mature cover, and phase-in of old-seral requirements in low BEO areas) reflects the approach provided by the provincial old-growth order. In this sensitivity analysis, the old-growth order approach was modelled. However, the deployment of high and intermediate BEOs by corridor within landscape units, as in the base case, was retained.
- As shown in Figure 26, the combination of these three modifications results in greater timber supply for the Revelstoke TSA. The base case initial harvest level can be maintained for four decades before beginning the same series of declines as in the base case to the mid-term harvest level. The base case mid-term harvest level is unaffected, and is reached two decades later than in the base case. Overall, the mid-term level is held for one decade less than in the base case before climbing to the long-term level. Overall, mid-term timber supply is 6.4% greater than in the base case.
- The long-term harvest level is 2.6% higher than that of the base case.

5.8 Uncertainty in the assumptions for managing caribou habitat

Mountain caribou populations, including the sub-populations in the Revelstoke TSA, have been declining and their geographic ranges shrinking for several decades. In 1993, the B.C. Conservation Data Centre (CDC) placed mountain caribou on the provincial blue list of "species at risk". In 2000, caribou were moved to the red list of "threatened or endangered" species because of continuing declines in abundance and substantial threats to their survival. In October 2002, the provincial Mountain Caribou Technical Advisory Committee (MCTAC) released a *Strategy for the Recovery of Mountain Caribou in British Columbia*. The MCTAC identified the population trends of what they considered to be 13 sub-populations in B.C. Eight of these, including the two populations in the Revelstoke area, north of Highway 1, had declined by more than 20% in the previous seven years, and none had increased during that time frame. In May 2002, the national Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated these and other mountain caribou sub-populations within B.C. as nationally threatened. At approximately the same time, new census information indicated that a significant decline in the local sub-populations, as well as in other populations, had occurred.

The MCTAC census results for the local populations and the need for recovery action planning for local herds outlined in the provincial recovery strategy prompted the City of Revelstoke to initiate discussions amongst interested parties about actions that could be taken to reverse the decline in local sub-populations. This group began its work in late 2002. Early in 2003, the provincial government began the development of a North Kootenay Recovery Action Plan under the federal *Species at Risk Act* for these sub-populations and the Central Selkirks sub-population. Both groups continue to work towards planning and implementing actions to halt population declines, and to restore these populations if possible.

This section provides a review of the caribou management requirements modelled in the base case, and a discussion of the results of sensitivity analysis that examined the potential impacts of uncertainties or changes in the caribou management regime.

Currently, about 72 000 hectares of the productive forest land base in the TSA is managed as caribou habitat. About 35 000 hectares of this is timber harvesting land base, correlating to 44% of the timber harvesting land base in the TSA.

Modelling assumptions used in the base case reflect management requirements for timber harvesting in the caribou habitat portions of the TSA. In the base case, forest cover requirements for caribou were defined in relation to the 1994 operability line, which is commonly referred to as the Caribou line. Some requirements apply above the Caribou operability line, while others apply to the forest below the Caribou line. Some land that was classified as inoperable in 1994 (i.e., above the Caribou line), is now below the current operability line and within the timber harvesting land base.

Caribou requirements will be referred to as mature (stands older than 140 years) and old-seral (stands over 250 years). The mature and old-seral forest cover requirements were applied to the Crown productive forest area with slopes less than 80% within each delineated habitat type, by landscape unit and biogeoclimatic zone.

The green-up objective applied to integrated resource management areas, whereby at most 25% of the area was to be covered in stands under 2 metres in height, was also applied.

In total, 72 210 hectares of forest were subject to caribou habitat requirements. The caribou habitat area was divided into three components. The bulk of the area—60 300 hectares (84%)—was subject to mature and old-seral requirements throughout the analysis horizon. This part of the habitat is called the caribou 'guidelines' area.

A second portion—'mapped immature' patches—covered 6460 hectares, or 9% of the productive forest in caribou habitat. Of that area, 3400 hectares was within the timber harvesting land base. The mapped immature area was subject to the same mature and old-seral requirements as the guideline areas. No harvesting was permitted in the immature areas for the first 80 years (the first rotation). These immature areas are not all very young; the average age of stands is 140 years outside of the timber harvesting land base and 113 years for those in the timber harvesting land base.

The third component, known as 'intermediate' caribou habitat, covered 5430 hectares and was subject to mature and old-seral requirements that apply to areas with intermediate biodiversity emphasis objectives. In the base case, cover requirements were applied separately to each of these three components (i.e., the guideline, mapped immature and intermediate areas were not grouped).

5 Timber Supply Sensitivity Analyses

The forest cover requirements for the guideline and mapped immature caribou areas were as follows:

- Above the Caribou line on slopes less than 80%, at least 70% of the area must be covered with forest older than 140 years of age;
- Below the Caribou line on slopes less than 80%, at least 40% of the area must be covered with forest older than 140 years of age, and at least 10% of the forest area must be older than 250 years of age.

The intermediate caribou habitat areas were subject to the following requirements:

- In the ICH: at least 13% of the area must have stands 250 years of age or older, and, at least 34% of the area must have stands 100 years or older;
- In the ESSF: a minimum of 19% of the area must be covered with stands 250 years of age or older; and, at least 36% of the area must have stands 120 years or older.

In total, 43 600 hectares or 60% of the total mapped caribou habitat was subject to the minimum requirements for stands older than 250 years of age.

Table 9 below summarizes the distribution of the land base managed for caribou habitat, and the management objectives applied in the analysis. The distribution of the areas both in and outside the timber harvesting land base is depicted in the table. The cover requirements applied to areas either above or below the caribou line. The distribution of habitat relative to the current timber harvesting land base provides a sense of which areas and seral requirements are most likely to affect timber supply.

Table 9. Summary of management objectives for caribou habitat applied in the base case — Revelstoke TSA, 2004

	Total area (hectares)	Guidelines habitat (hectares)		Mapped immature (hectares)		Managed to objectives for intermediate BEOs[a] (hectares)
		Minimum 70%, 140 years or older	Minimum 40%, 140 years or older; and, minimum 10% 250 years or older	Minimum 70% 140 years or older; and no harvest for first 80 years	Minimum 40% 140 years or older; minimum 10% 250 years or older; and no harvest for first 80 years	
2004 Timber harvesting land base						
Below Caribou line	30 579		25 032		3 219	2 328
Above Caribou line[b]	4 471	4 164		179		128
Outside 2004 timber harvesting land base						
Below Caribou line	10 943		8 625		1 300	1 018
Above Caribou line	26 217	22 502		1 759		1 956
Total area	72 210	26 666	33 657	1 938	4 519	5 430

(a) In the ICH: at least 13% of the area covered with stands 250 years of age or older; and, at least 34% of the area covered with stands 100 years or older. In the ESSF: at least 19% of the area covered with stands 250 years of age or older, and, at least 36% of the area covered with stands 120 years or older.

(b) The 1994 operability line is relevant because caribou forest cover requirements are tracked on the land base that was operable in 1994. However, operability information has changed since 1994. This table shows that some area that was classifies as inoperable in 1994 is within the timber harvesting land base (4471 hectares). Likewise, 10 943 hectares that were classified as operable in 1994 are outside of the 2004 timber harvesting land base (although not all of the area below the 1994 operability line was in the 1994 timber harvesting land base either, due to reasons other than operability).

5 Timber Supply Sensitivity Analyses

Caribou habitat management is subject to ongoing reassessment, in particular due to the concerns about the current size of the Revelstoke caribou herd and the importance of maintaining connectivity between habitat areas and sub-populations, as well as the desire to ensure that the guidelines meet management objectives over time. Modifications could be made to either the amount of area managed for habitat, or to the forest cover objectives applied to the habitat. The timber supply impacts of such modifications are of interest to the groups engaged in caribou habitat management in the TSA. Sensitivity analyses were conducted to assess the impact of changing specific aspects of the analysis assumptions for caribou habitat.

Caribou sensitivity analysis 1: Combine all caribou habitat areas, apply full caribou mature and old-seral guidelines to all areas

- In this sensitivity analysis, the 'mapped immature" areas were grouped with the 'guideline' caribou habitat areas by operability, landscape unit and biogeoclimatic zone, and the mature and old-seral requirements were applied. The base case requirement that no harvesting occur in the mapped immature areas within the timber harvesting land base (3398 hectares, see Table 9) for the first 80 years was not applied in this sensitivity analysis.
- In addition, the 5430 hectares of "intermediate" caribou area, modelled in the base case with intermediate BEO forest cover objectives, was grouped with the guideline and mapped immature habitat areas, and the same forest cover requirements applied to the entire area.
- The results of this analysis, not shown in graphical format, indicate that timber supply is relatively insensitive to these changes in assumptions, for reasons explained in the next point. Short- and mid-term timber supplies are unaffected relative to the base case. The only impact is that the long-term level could not be achieved until decade 22, six decades after the base case. As a result, the cumulative long-term timber supply (measured between 140 and 250 years from the start of the analysis horizon) is reduced by 1.8%.
- Grouping the mapped immature areas into the guideline habitat and removing the no harvest constraint increases harvest flexibility. This flexibility is counteracted by increased requirements for the intermediate caribou habitat areas. The proportion of intermediate area required to be covered by mature stands increased to 40% from the base case levels of 34 or 36% depending on BEC zone, and the mature age was increased from 100 or 120 years to 140 years. However, the proportion of area required to be covered in stands older than 250 years decreased from 13 or 19% in the base case, to 10% on the area below the caribou line. No forest cover requirement was applied to inoperable areas in the intermediate habitat as no harvesting was modelled in those areas.
- Overall, if the mapped immature caribou habitat as well as the intermediate caribou habitat in the TSA were grouped and managed with the guideline caribou areas, timber supply would be affected only slightly in the long term.

Caribou sensitivity analysis 2: Apply mature and old-seral requirements to an expanded caribou area

The following changes were made relative to the base case for this sensitivity analysis:

- Mapped immature and intermediate caribou areas were grouped with guideline areas, and full mature and old-seral requirements were applied. Harvesting was permitted in the mapped immature areas over the first 80 years. (Same as previous sensitivity analysis.)
- The 'guideline' caribou requirements as used in the base case were applied to all operable area in the Red Rock (R6) and Liberty (R14) landscape units, and to all operable area in the ESSF in the Soards landscape unit (R16). Most of the area in these landscape units had not previously been identified as caribou habitat. The 1994 operability information was not available for these additional areas. Therefore the 2001 operability information was used to delineate the additional operable land base in these landscape units, and the guideline operable caribou habitat objectives were applied. These areas were selected after consultation with local biologists, and were included because they have parcels of land that are being used by caribou. The total operable area to which the additional guideline constraints was applied was 15 800 hectares, while about 12 100 hectares of this was not assumed to be managed for caribou habitat in the base case.

5 Timber Supply Sensitivity Analyses

- The forest cover requirements for guideline areas below the caribou line (at least 40% of the area covered with stands greater than 140 years of age and at least 10% with stands greater than 250 years of age) were applied on the entire operable land base by biogeoclimatic zone (as noted above, in the Sourds landscape unit only the ESSF zone was subject to the requirements).

- Figure 27, below, shows the results of this sensitivity analysis. The base case initial harvest level can be maintained for one decade before declining to a mid-term harvest level of 155 000 cubic metres per year (6% lower than in the base case), reached in decade 5. The long-term harvest level is 2.9% lower than that in the base case. Overall, short-term timber supply is reduced by 4.8%, mid-term timber supply by 6.7%.

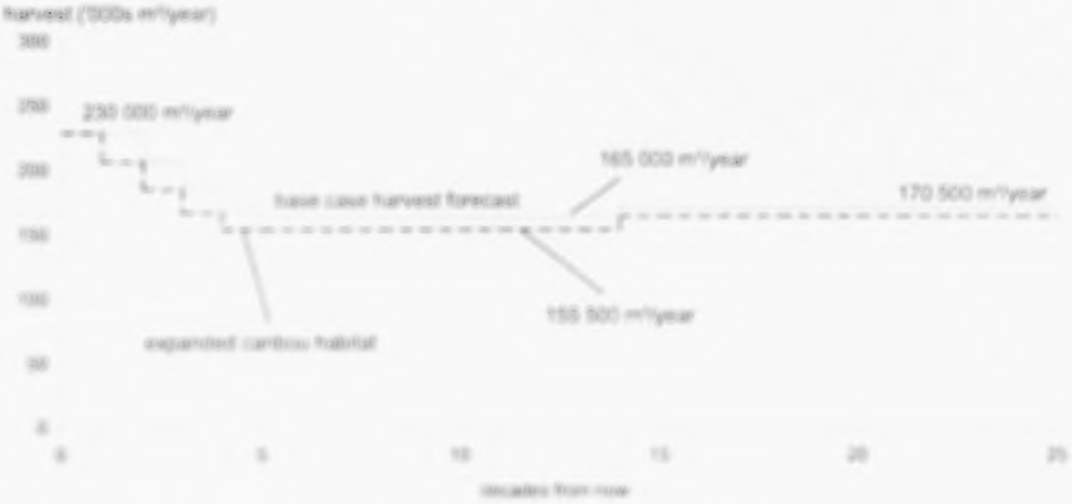

Figure 27. The effect on the harvest forecast of expanding the amount of operable area managed for caribou habitat — Revelstoke TSA, 2004.

Caribou sensitivity analysis 3: Increase the forest cover constraint for the operable caribou areas

- A series of analyses were done to examine the implications of increasing the requirement for mature forest (140 years of age or older) below the caribou line. The requirement was increased to at least 60% of the area below the caribou line, rather than 40% as in the base case. While the MAC recommendations are for 40% retention of mature forest, the potential desirability of a mature forest retention rate of 60% is documented in several research reports (e.g. Armleder *et al.* 2000, Simpson *et al.* 1988, 1994, 1997).

  Three analyses were done. The first used the same approach as in the base case, except for the increased mature forest requirement. In the second, all caribou habitat components (guideline, immature, intermediate) were combined and the "guideline" requirements applied as in caribou sensitivity analysis 1, plus the increased mature requirement was applied on the area below the caribou line. Finally, the increased mature requirement was applied to the expanded caribou habitat area described in caribou sensitivity analysis 2.

- The results of the first two analyses—applying the increased requirement to the base case and to the combined caribou areas—are shown in Figure 28.

- When the only the increased requirement was applied to the base case habitat areas, an initial harvest level of 203 000 cubic metres per year, or 12% below that in the base case, could be maintained for one decade before declining in three steps to the mid-term harvest level. The mid-term level of 147 000 cubic metres per year, 11% lower than that in the base case, increased to the long-term harvest level of 151 000 cubic metre per year in decade 14. The long-term level is 11.4% below the base case long-term level. Overall, when the increased mature requirement was applied, short-term timber supply was reduced by 16.1% compared to the base case. Mid-term timber supply was 13.1% lower. The increase in the percentage of area required in mature stands below the caribou line significantly reduces timber supply. Since 74% of the area below the caribou line falls within the timber harvesting land base (see Table 9), the additional retention requirement directly affects the ability to achieve the base case harvest levels.

- Applying the increased mature forest requirement to the combined caribou areas resulted in the same short- and mid-term supplies with a slightly lower long-term level (147 000 cubic metres per year) as when only the requirement was increased on the base case caribou areas. As in caribou sensitivity analysis 1, the results of this analysis show that grouping of the caribou habitat components does not in itself affect timber supply significantly. The observed impact relates to the increased mature forest requirement.

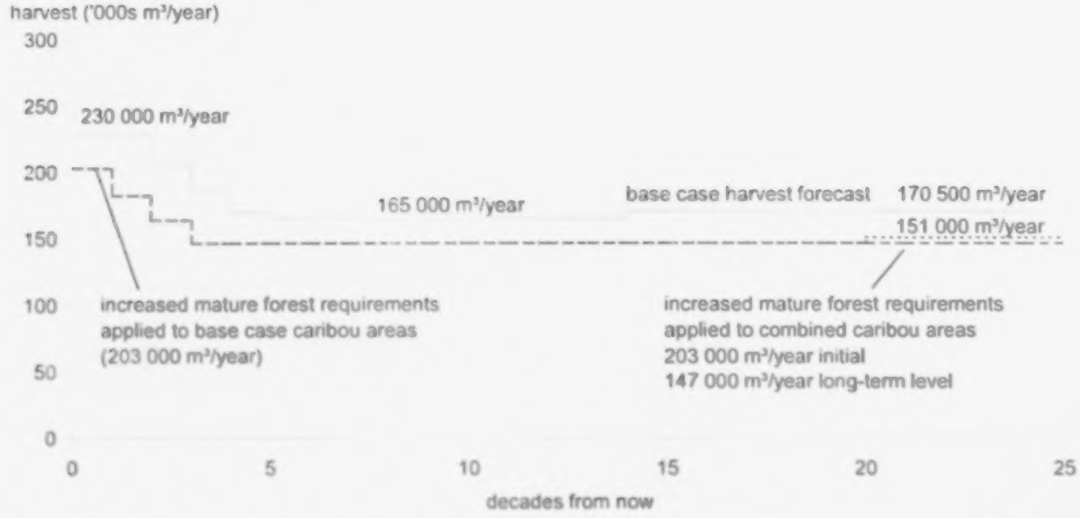

Figure 28. The effect on the harvest forecast of increasing the forest cover constraint in operable caribou habitat areas — Revelstoke TSA, 2004.

5 Timber Supply Sensitivity Analyses

- Figure 29 shows the implications of applying the increased mature requirement to the expanded caribou land base. Requiring a minimum of 60% of the operable forest in the expanded caribou area to be at least 140 years old caused an immediate reduction of 17.8%. The mid-term harvest level is 25% below that of the base case, and is held until the 16th decade. The long-term harvest level of 133 000 cubic metres per year is 22% below that of the base case long-term harvest level. Overall, short-, mid-, and long-term timber supply are reduced by 22%, 25.2 and 22.5%, respectively.

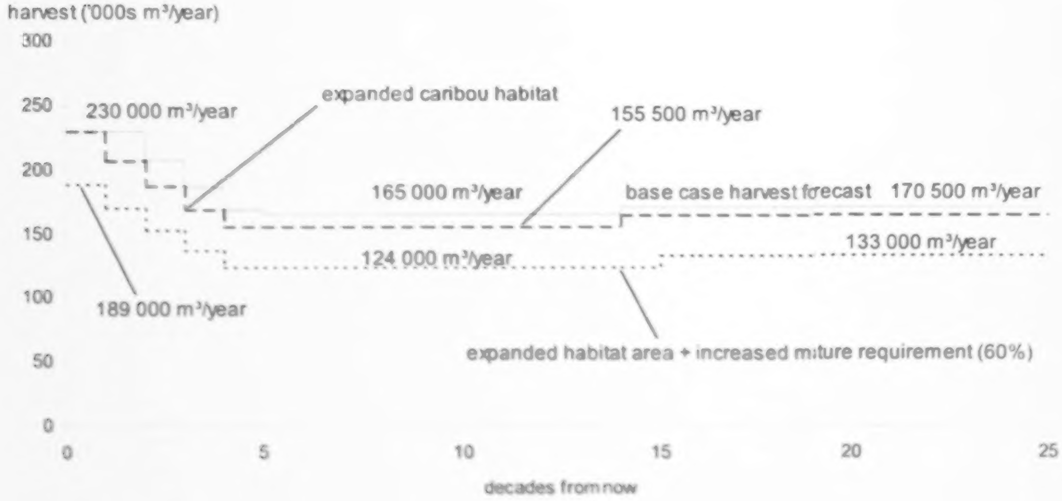

Figure 29. Impacts of applying increased mature forest cover requirements to the expanded caribou habitat area — Revelstoke TSA, 2004.

These sensitivity analyses demonstrate that significantly increasing requirements for mature forest cover in caribou habitat areas could substantially decrease timber supply over all time frames. The large impacts occur because in the base case, the requirements for mature forest apply to a substantial portion of the timber harvesting land base (about 32%). The requirements apply to an even greater portion of the timber harvesting land base in the expanded caribou area analyses.

Caribou sensitivity anlysis 4: the timber supply impact of base case cribou habitat management

To understand the implications of the current caribou management egime, a sensitivity analysis was done in which all caribou requirements were removed. This is not to suggest that such a change might be made, but oly to develop a better understanding of the role of caribou management in defining timber suppl for the TSA.

Figure 30, next pge, displays the results.

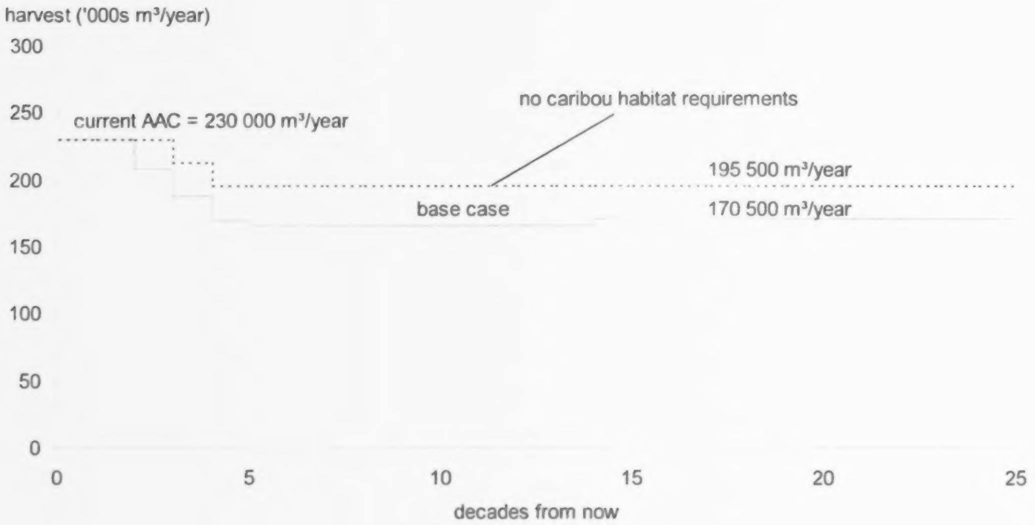

Figure 30. Impact of caribou habitat management in the Revelstoke TSA — 2004.

Without caribou management requirements, the current AAC of 230 000 cubic metres can be held for one decade more than in the base case. The projected timber supply is 17% higher in mid-term and 14.7% higher in the long term.

Since caribou habitat requirements apply to 32% of the forest and 45% of the timber harvesting land base, it is not surprising that removal of those requirements results in a substantial increase in timber supply.

5.9 Uncertainty in the assumptions for managing ungulate habitat

Deer and moose are two ungulate species present in the Revelstoke TSA. Current management includes maintenance of specific forest cover to meet habitat objectives for these species. Habitat requirements for both deer and moose were modelled in the analysis.

In the Revelstoke TSA, deer habitat covered about 11 100 hectares of productive forest (7360 hectares of timber harvesting land base) in the Cranberry (R2), Akolkolex (R3), Jordan (R7), Frisby Ridge (R8), LaForme (R10), and Illecillewaet (R20) landscape units. Moose habitat covered about 18 800 hectares of productive forest and 14 900 hectares of timber harvesting land base in the Red Rock (R6), Jordan (R7), Frisby Ridge (R8), Big Eddy (R11), Liberty (R14), Horne (R15), Soards (R16), and Big Mouth (R18) landscape units. The deer and moose habitat areas modelled in the analysis did not overlap. Forest cover objectives for at least 40% of the forest area to be covered in stands 120 years of age or older were applied to the identified habitat areas by landscape unit. Green-up objectives were also applied.

The current ungulate winter range (UWR) habitat areas and associated guidelines are expected to be replaced by new maps and guidelines proposed by the West Kootenay Ungulate Winter Range Committee (chaired by staff from the Ministry of Water, Land and Air Protection). Final objectives or notices under Section 7(2) of the Forest Planning and Practices Regulation may be in place by the spring of 2005. The new guidelines are expected to include differing forest cover constraints for mule deer, moose heavy snowfall, and moose moderate snowfall areas, and to change the boundaries of some of the delineated habitat areas.

To assess the timber supply implications of modifying the ungulate areas and forest cover objectives to reflect the revised guidelines, two sensitivity analyses were performed.

5 Timber Supply Sensitivity Analyses

Revised forest cover objectives for deer and moose habitat, applied to modified habitat areas

- In the first sensitivity analysis, forest cover objectives were applied to a total of 24 200 hectares of productive forest to account for management in ungulate habitat.
- For the sensitivity analysis, deer habitat was modelled only in the Akolkolex (R3) and Illecillewaet (R20) landscape units. The deer range modelled in the base case in the landscape units on the west side of Upper Arrow Lake in the south of the TSA – Cranberry (R2) and Mulvehill (R4) – was believed to better reflect moose habitat, and therefore was modelled as such in this sensitivity analysis, as described in the next bullet. New mapping that delineates a small band of deer winter range in these two landscape units, as well as in the Pingston (R1) and Jordan (R7) landscape units was not available for use in this sensitivity analysis. The total area modelled as deer habitat was 3400 hectares, or about a third of the deer habitat area in the base case. The forest cover objective for deer habitat was changed so that at least 40% of the habitat area needed to be covered by stands at least 100 years of age (compared to 120 years in the base case).
- Moose habitat consists of moderate and heavy snowfall areas. Forest cover objectives for these areas are that at least 20% (moderate snowfall) and 30% (heavy) of the area must be covered by stands at least 60 years of age (*versus* 40% above 120 years old in the base case). Moose heavy snowfall areas were assumed to be located in following landscape units: Red Rock (R6), Jordan (R7), Frisby Ridge (R8), LaForme (R10), Big Eddy (R11), Liberty (R14), Horne (R15), Soards (R16) and Big Mouth (R18). Moose moderate snowfall areas were located in Pingston (R1), Cranberry (R2) and Mulvehill (R4). The current ungulate winter range line work was used to define areas subject to the changed forest cover objectives. As mentioned above, the available deer linework in the Cranberry and Mulvehill landscape units was used, as well as that for the LaForme landscape unit. The total productive forest modelled as moose habitat was 20 800 hectares. All but 400 hectares of this was moose heavy snowfall habitat.
- The results of the sensitivity analysis, shown in Figure 31, indicate that timber supply is not highly sensitive to the constraints being revised as described. Short- and mid-term timber supply were. A long-term harvest level 2.3% higher than in the base case could be achieved. If ungulate habitat requirements were revised in the Revelstoke TSA in the manner described in this sensitivity analysis, timber supply is unlikely to be affected.

Change the forest cover objectives and areas as above, but also relax the moose winter range requirements north of Revelstoke

- This sensitivity analysis explored the implications of not managing moose heavy snowfall habitat located north the city of Revelstoke. The forest cover objectives for moose were applied only to the Cranberry and Mulvehill landscape units, for a total of about 400 hectares of productive forest. Deer habitat area and management assumptions were the same as in the first sensitivity analysis (about 3400 hectares of productive forest).
- The results indicate that timber supply is insensitive to a large reduction in requirements for managing moose heavy snowfall habitat. The results are not shown in Figure 31 because short-term timber supply was unaffected and the mid-term harvest level was only very slightly higher (1000 cubic metres per year) than in the previous sensitivity analysis ("Revised forest cover objectives for deer and moose habitat, applied to modified habitat areas"). The long-term harvest level was the same as in first deer and moose sensitivity analysis (174 500 cubic metres per year compared to 170 500 cubic metres in the base case).

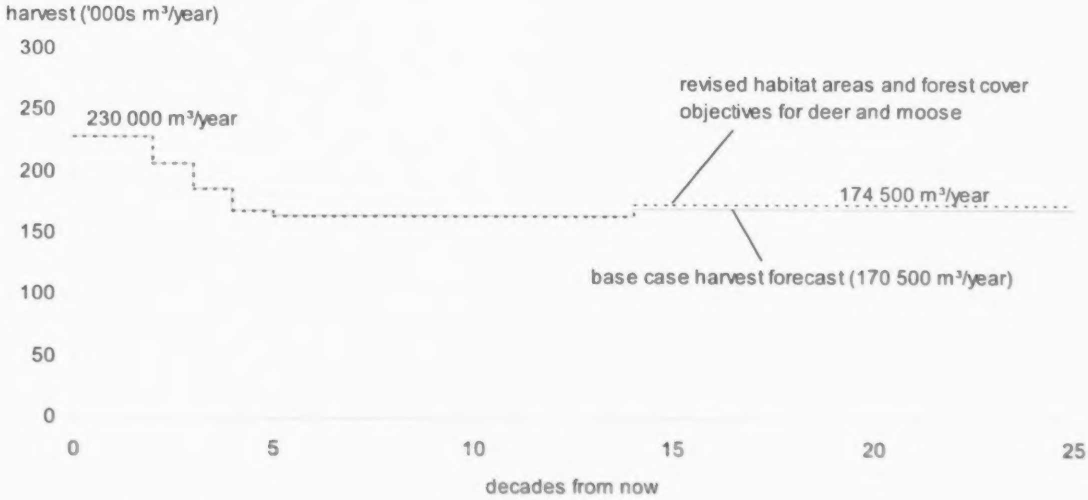

Figure 31. The implications to the harvest forecast if assumptions regarding deer and moose habitat are modified — Revelstoke TSA, 2004.

5.10 Uncertainty in the assumptions for both caribou and ungulate habitat

Management for caribou, deer and moose habitat forms part of current practice in the Revelstoke TSA. In the preceding two sections, the base case assumptions for the management of these species have been described, in conjunction with the implications to timber supply of varying specific aspects of the assumptions. Two sensitivity analyses were performed, in which changes to habitat areas and forest cover requirements for both caribou and ungulate were made.

5 Timber Supply Sensitivity Analyses

In the first analysis, a large reduction was made in the area managed for moose, in that no management in moose heavy snowfall habitat was modelled. The total area subject to forest cover constraints for ungulates was about 3800 hectares. Forest cover objectives for deer habitat, and moose moderate snowfall areas, were applied as described in Section 5.9, "Uncertainty in the assumptions for ungulate habitat." In addition, all caribou habitat areas were combined for application of forest cover requirements to an expanded caribou area (as in caribou sensitivity analysis 2, Section 5.8). All of those changes were retained in the second analysis, and in addition the requirement for mature forest was increased to 60% at or above 140 years from 40% in the base case (as in caribou sensitivity analysis 3 in Section 5.8).

These changes are of interest in the Revelstoke TSA because of the potential for important caribou habitat to be compromised by management for moose habitat. These analyses also help to assess whether relaxing moose habitat management could mitigate timber supply impacts resulting from increasing both the area of caribou habitat and the seral-stage* retention requirements.

The results of both sensitivity analyses are depicted on the graph below, in combination with the results of the original caribou sensitivity analyses, for reference.

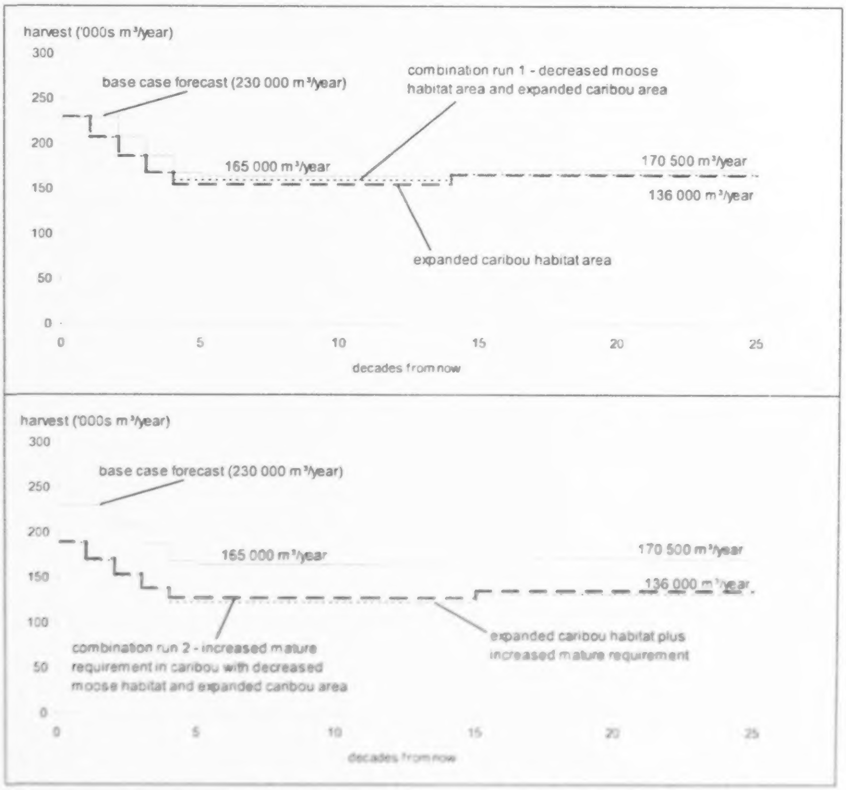

Figure 3. Forecasts showing impacts of simultaneously changing ungulate (moose) and caribou habitat areas and management requirements — Revelstoke TSA, 2004.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

The results of the first combination run (Figure 32) show that relaxed ungulate constraints only mitigate to a very small degree increases in the operable area managed for caribou habitat. Short-term timber supply was the same as when modified caribou constraints were applied alone, while both mid- and long-term timber supply were slightly higher. Relative to the base case, short-term timber supply was 4.8% lower, mid-term timber supply was 4.5%, lower and long-term timber supply was reduced by 2.1% (compared to 4.8%, 6.7% and 2.9%, respectively, in the sensitivity analysis with increased operable caribou habitat area alone).

Similarly, reductions in the area managed for moose would increase mid- and long-term timber supply only slightly if both the caribou areas were expanded and the mature forest cover requirements for caribou habitat were increased. Short-term timber supply was only 0.5% higher, while mid- and long-term timber supply were both 1.9% higher than when the caribou area and cover requirements were increased without modifications to moose habitat management.

5.11 Uncertainty in the assumptions around visual quality management

In the Revelstoke TSA, visual quality objectives (VQOs) apply to 18% of the Crown productive forest, and nearly 24% of the timber harvesting land base. About 8100 hectares of timber harvesting land base are in partial retention VQOs, about 1400 hectares are in retention VQOs and about 9000 hectares are in modification VQOs.

In the base case, forest cover objectives for retention, partial retention and modification VQOs were modelled. Green-up heights of 6 metres were applied to areas with retention and partial retention VQOs, and 2 metres to areas with modification VQOs. A maximum of 5%, 15% and 25% of stands in the Crown productive forest area could be below the specified green-up height in retention, partial retention and modification areas, respectively.

A sensitivity analysis was conducted to assess the implications to timber supply if the requirements were relaxed slightly for areas with retention and partial retention objectives. The results are shown in the figure below.

5 Timber Supply Sensitivity Analyses

Allowable visual disturbance set at mid-point of the next least restrictive range

- In the sensitivity analysis, the level of disturbance permitted in areas with retention VQOs was increased to the level allowed in the base case for partial retention VQOs (from 5% to 15%). The level permitted in areas with partial retention VQOs, was increased to that allowed for areas with modification VQOs (from 15% to 25%). However, the green-up height used to determined ages in partial retention areas was kept at 6 metres, rather than the 2 metres applied in modification VQO areas in the base case.
- The harvest forecast is shown in Figure 33 below. The base case short-term harvest level was held for two decades before beginning to decline to a mid-term level 9.7% higher than that in the base case. Overall, mid-term timber supply was 7.6% greater than in the base case, while the long-term harvest level was 7.3% higher.

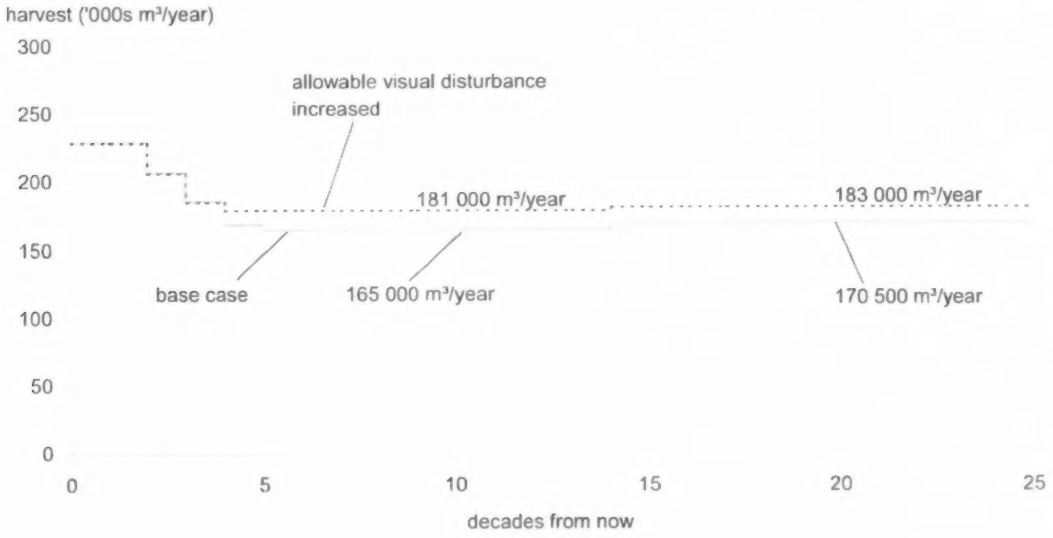

Figure 33. Impact of increasing allowable disturbance in visual management areas — Revelstoke TSA, 2004.

5.12 Uncertainty in the level of disturbance outside the timber harvesting land base

Although no timber harvests occur in forests outside the timber harvesting land base, those forests do contribute to landscape-level biodiversity, habitat and other values. Therefore conditions in the non-timber harvest land base can affect timber supply by reducing the need to retain stands within the timber harvesting land base. The role of the non-timber harvesting land base in achieving management objectives was accounted for in the base case.

In the base case, the rate of natural disturbance outside the timber harvesting land base was estimated in order to reasonably approximate the contribution of those forests to management objectives. (For natural disturbances on the timber harvesting land base, the average level of unsalvaged losses were deducted from the timber supply forecasts, while average rates of salvage were included in the forecasts.)

In the analysis for the Revelstoke TSA, the expected disturbance rate outside the timber harvesting land base was calculated using information from the *Biodiversity Guidebook* on natural disturbance return intervals, and the proportions of the land base expected to be occupied by stands older than 250 years of age. The disturbance values were calculated separately for each biogeoclimatic zone and NDT combination. This calculation resulted in a total disturbance value of 300 hectares per year outside the timber harvesting land base. In the analysis, only stands over 50 years of age were disturbed, to reflect the higher likelihood that stands beyond that age would be subject to disturbance. District staff reviewed this information in conjunction with recent estimates of losses and recommended a disturbance regime of twice this amount, or 600 hectares per year. This latter number was applied in the base case. The values were applied by landscape unit, biogeoclimatic zone and NDT combinations.

Since the disturbance rate is uncertain, sensitivity analysis was used to assess the implications of other disturbance values. The analysis for the Revelstoke TSA indicated that the assumptions regarding natural disturbance have a significant impact on the projected availability of timber supply.

Two sensitivity analyses were performed. In the first, a disturbance rate of 300 hectares per year—the overall value calculated from the *Biodiversity Guidebook*—was applied. In the second, no disturbance in the non-timber harvesting land base was assumed. This latter option does not reflect the expected occurrence, but was evaluated to provide an understanding of the significance of the disturbance regime in defining. The results are depicted in Figure 34 below.

If the disturbance rate outside the timber harvesting land base were half that in the base case, the short-term timber supply would remain unchanged, while cumulative mid-term timber supply would be 11.9% higher, and the long-term harvest level 11.4% higher than in the base case. The lowest mid-term level would be 15% higher than the base case mid-term level. Analysis results not shown in Figure 34 indicated that it would be possible to maintain the current AAC for three decades with the lower disturbance rate. If that were done, cumulative mid-term supply would be 10.5% higher than in the base case (but the lowest mid-term level would be only 6.7% above the base case level). The long-term level would still be 11.4% higher than in the base case.

If there were no disturbance outside the timber harvesting land base, and stands there continued to age throughout the analysis horizon, the initial level could be maintained for one decade longer than in the base case. The mid-term timber supply would be 17.8% higher than in the base case, and the long-term harvest level would be 24% higher.

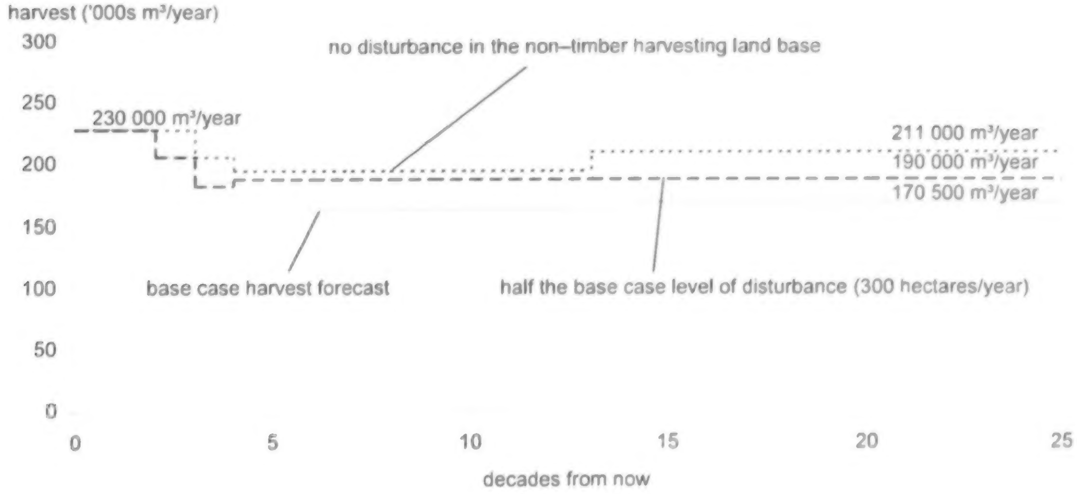

Figure 34. Implications of changes in the level of disturbance in the non-timber harvesting land base — Revelstoke TSA, 2004.

5 Timber Supply Sensitivity Analyses

In the base case, forest stands outside of the timber harvesting land base that were disturbed reverted to an age of zero years (the disturbance method is discussed in Section 4, "Results" in particular related to the age class profile over time). If stands revert to zero years of age, they add to the area of stands that does not meet green-up height, and therefore may constrain timber supply. There is uncertainty about whether or not forest outside the timber harvesting land base should be considered with respect to green-up requirements. For example, some might claim that disturbances outside the timber harvesting land base should not constrain availability of timber on the timber harvesting land base. Therefore, a sensitivity analysis was done in which the reversion age for disturbed stands outside the timber harvesting land base was set to 30 years. Stands of such an age would have already reached green-up height.

Figure 35 below shows the results of the analysis. The initial level could be maintained for an additional decade compared to the base case, while the mid-term timber supply was 6% higher than in the base case, and the long-term level was 8.5% higher.

This sensitivity analysis demonstrates that assumptions about the role of disturbed stands outside the timber harvesting land base with respect to forest management objectives can have a significant impact on timber supply projections.

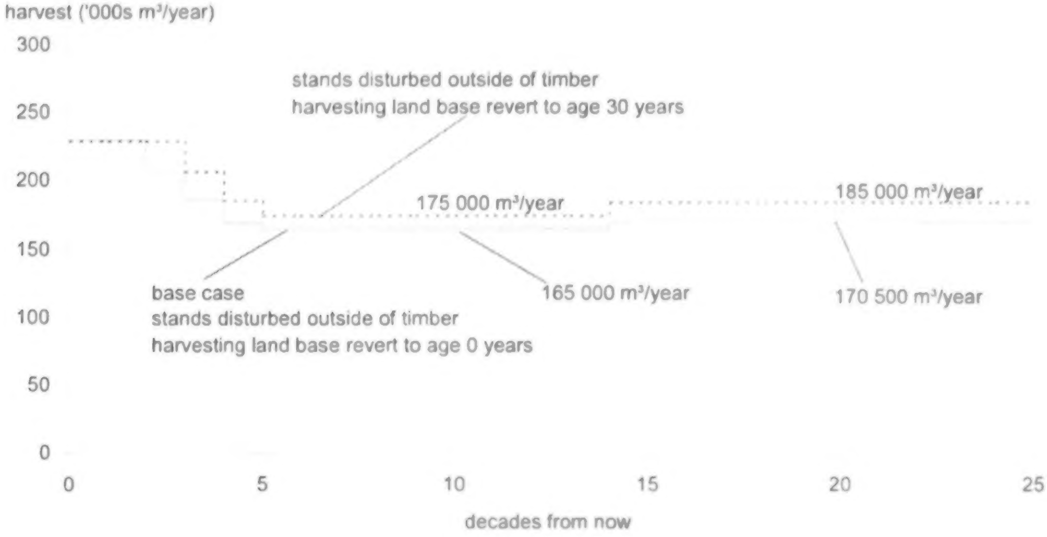

Figure 35. Impacts of changing the reversion age of naturally disturbed stands outside of the timber harvesting land base — Revelstoke TSA, 2004.

5.13 Uncertainty in harvest order of stands

In the base case, the priority of a stand for harvest was based on the following criteria:

- For the first decade of the analysis horizon only, a priority was placed on stands proposed for harvest within forest development plans (category A blocks).
- For the first three decades of the analysis horizon, cedar- and spruce-leading old-growth stands were given a harvest priority, to reflect current operational harvesting choices.
- The relative oldest first harvest rule was applied, which sets a priority on stands that are the oldest relative to their minimum harvestable age.

The combination of these harvest priorities in the short term was used to reflect current harvesting patterns in the Revelstoke TSA.

The timber supply implications of using other possible harvest sequencing rules was assessed in sensitivity analyses. The resulting harvest forecasts were not flowed, but rather illustrate at what point the base case harvest forecast is affected by the changes in stand sequencing. Figure 36 below shows the results of the sensitivity analyses.

Absolute oldest first harvest rule

- This rule sets the highest priority on the oldest stands (that is, not related to minimum harvestable age).
- In this sensitivity analysis, the base case priorities on category A block for the first decade, and on cedar- and spruce-leading stands, were retained.
- The harvest forecast was not affected until the 17th and 18th decades, where the projected harvest level dropped to a low of 146 636 cubic metres. Further disruptions occurred starting in the 22nd decade and continued to the end of the analysis horizon. The results indicate that if the oldest stands were always selected for harvest regardless of minimum harvestable ages, long-term timber supply would be reduced on average by 3.3% in the Revelstoke TSA.

Absolute youngest first harvest rule

- This rule sets the highest priority on the youngest stands that are over their minimum harvestable age. While this is not a commonly-used priority rule, focusing harvesting in the youngest available stands might be proposed so that older stands are left unharvested for as long as possible. In the Revelstoke TSA, however, forest cover requirements are specifically applied to ensure sufficient older forest is retained to meet management objectives.
- In this sensitivity analysis, the base case priorities on category A block for the first decade, and on cedar- and spruce-leading stands, were retained.
- These results are not depicted on the figure below. The harvest forecast under the youngest first harvest rule was unaffected over the 250 year analysis horizon, although the forecast is reduced just after the 25th decade.

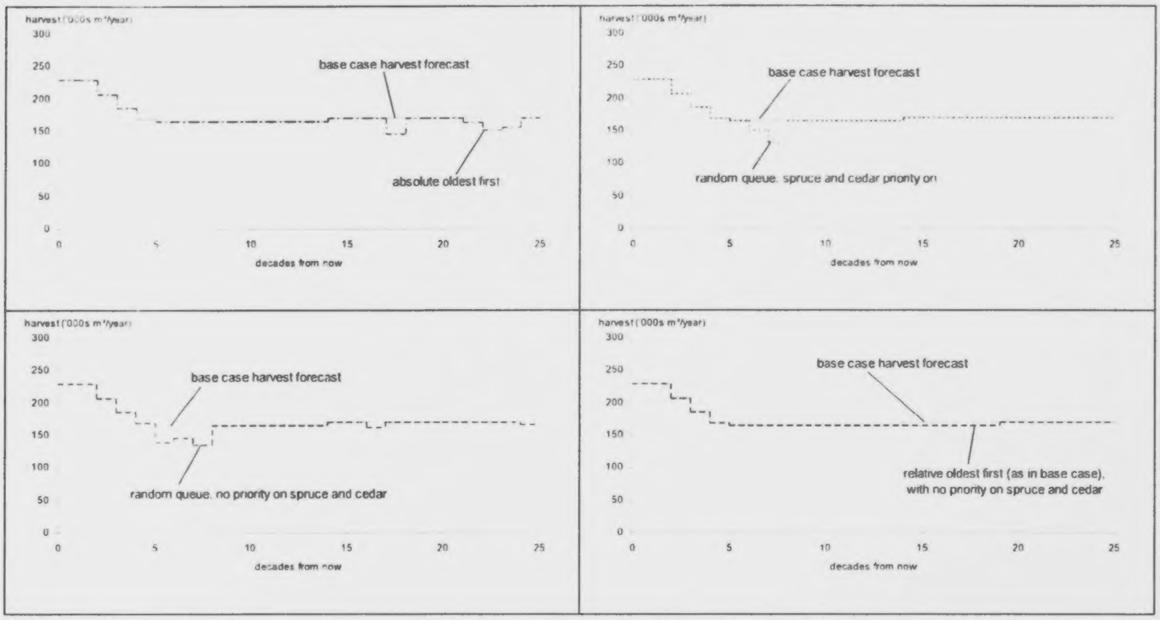

Figure 36. Alternative harvest queue (priority) rules — Revelstoke TSA, 2004.

Random first harvest rule

- This harvest rule selects stands that are older than their minimum harvestable ages at random.
- In this sensitivity analysis, the base case priorities on category A block for the first decade, and on cedar- and spruce-leading stands, were retained.
- The short-term harvest level was unaffected, but beginning in the 6th decade, the harvest forecast could not be met, and the level dropped to 139 364 cubic metres per year. Cumulative mid-term timber supply was 2.2% lower than in the base case. Long-term supply was nit affected.
- Overall, it was not possible to meet the base case harvest forecast if stands were selected at random rather than based on the oldest stands relative to minimum harvestable ages.

Random harvest rule, spruce- and cedar-leading stand priority off

- In this sensitivity analysis, the random harvest rule was again applied. The base case assumptions regarding the category A block harvest priority for the first decade were retained, but priority was not placed on cedar- and spruce-leading stands.
- Disruptions relative the base case timber supply forecast harvest occurred in decades 6 though 8, with some small disruptions over the long term. cumulative mid-term supply was 3.6% less than in the base case, and long-term timber supply was 0.6% lower than in the base case.

Relative oldest first harvest rule, spruce- and cedar-leading stand priority off

- In this sensitivity analysis, the base case assumptions regarding the relative oldest first harvest rule, and the category A block harvest priority for the first decade were retained, but priority was not placed on cedar- and spruce-leading stands. This harvest forecast was flowed to illustrate the implications to timber supply more clearly.
- Timber supply was unaffected in the short-term, and the mid-term level was the same as in the base case. However, the long-term harvest level, the same as in the base case, could not be achieved until decade 19, five decades after the base case, a reduction in the cumulative long-term timber supply measured from 140 to 250 years from now, by 1.5%.

Overall, this series of sensitivity analyses indicates that harvest priority does not have a significant impact on timber supply. In the Revelstoke TSA, the primary factors determining the harvest sequence and timber supply are the forest cover requirements applied to achieve objectives for biodiversity, wildlife habitat and visual quality.

5.14 Uncertainty in green-up ages

Adjusting green-up ages by 5 years

Green-up requirements were applied to meet objectives for visual quality, wildlife, and cutblock adjacency in this analysis. Green-up requirements are defined by both the percentage of area allowed below green-up height and the number of years it takes for a stand to achieve a greened-up condition. In the analysis for the Revelstoke TSA, the implications of adjusting the ages to achieve green-up by 5 years were assessed. The results of the sensitivity analysis indicate that short- and mid-term timber supply are not sensitive to adjustments in green-up ages. Reducing green-up ages by 5 years increased the long-term harvest level by 2.9% to 175 500 cubic metres per year, and delayed the achievement of the long-term level by one decade.

Increasing green-up ages by 5 years resulted in a long-term harvest level of 166 000 cubic metres per year, 2.6% lower than in the base case, and a very small (0.5%) drop in mid-term supply. Short-term timber supply was not affected.

5.15 Uncertainty about unsalvaged losses

The base case estimate for unsalvaged losses (9219 cubic metres per year) was based on information from 1995 through 2001. If new information on fires from 2003 were added to the data set used to estimate unsalvaged losses, the overall estimate would increase to 27 750 cubic metres per year. This increase in the estimate is due entirely to wildfires. No new information was available to revise estimates of unsalvaged volumes for other factors. The new information highlights the uncertainty associated with estimating unsalvaged losses, since data from a single year can greatly alter estimates. It is impossible to know with certainty the correct time span over which to measure such losses, in particular because future weather and economic conditions are difficult to predict. For the timber supply review, information is gathered for as long a time frame as possible while trying to ensure that the data used apply within the context of current protection and salvage programs.

A sensitivity analysis was done to examine the impacts of uncertainty in the estimate of average unsalvaged losses. The losses were increased to 25 000 cubic metres per year. Figure 37 shows the resulting harvest forecast.

If unsalvaged losses were 25 000 cubic metres per year, the current AAC could be maintained for only one decade before declining. The lowest mid-term level would be 9% lower than in the base case. Cumulative timber supply over the mid term would be 8.5% less than in the base case and the long-term harvest level would be 10.3% lower.

This sensitivity analysis demonstrates that the base case harvest forecast is sensitive to changes in the estimate of unsalvaged losses. It should be noted that the increase in losses examined here (to a level about 2.7 times the figure used for the base case) was quite large.

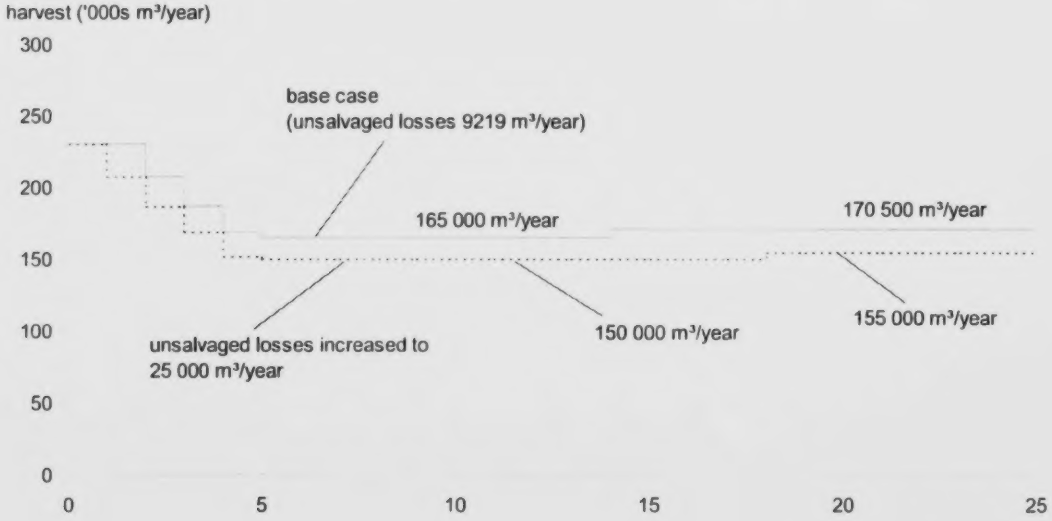

Figure 37. Timber supply impacts of increasing unsalvaged losses to 25 000 cubic metres per year — Revelstoke TSA, 2004.

5.16 Summary of sensitivity analysis impacts

Table 10 summarizes all the sensitivity analyses that showed some impact to timber supply relative to the base case harvest forecast, and the time frame over which that impact occurred. In the Revelstoke TSA analysis, the short term is described as the first two decades, the mid term is the period from the third decade through the 14th decade, and the long term is the period of time thereafter (the time after which the long-term harvest level is attained).

Table 10. Summary of sensitivity analyses for the Revelstoke TSA, 2004

Report section	Description	Impact of sensitivity analysis assumptions relative to the base case timber supply (%)[a]		
		Short term[b]	Mid term	Long term
5.1	Alternative harvest flow — 5% declines	-2.5	+2	-2
5.1	Alternative harvest flow — non-declining harvest	-26	-0.1	+1
5.1	Alternative harvest flow — higher initial harvest level	+6	-0.1	-1
5.2	Timber harvesting land base increased by 10%	—	+8.5	+11
5.2	Timber harvesting land base decreased by 13%	-14	-15	-13
5.2	Stands with more than 59% hemlock species excluded	-30	-23	-20
5.2	Stands with more than 79% hemlock species excluded	-14	-6	-6
5.2	Exclusion of a specific geographic area — Mount MacKenzie polygons excluded	-3	-3	-3
	–alternate harvest flow	—	-4	-2
5.3	Unmanaged stand volume estimates increased by 10%	—	+8	—
5.3	Unmanaged stand volume estimates decreased by 10%	-14	-8.5	—
5.4	Managed stand volume estimates increased by 10%	—	+2.5	+11
5.4	Managed stand volume estimates decreased by 10%	—	-7	-10
5.5	Old-growth site index adjustments from veteran study applied	—	+7	+19
5.4	Future genetic gain values applied	—	—	+3.5
5.5	Old-growth site index adjustments from paired-plot study applied	—	—	+3
5.6	Minimum harvestable ages for existing unmanaged stands changed to 95% CMAI	—	—	—
5.6	Minimum harvestable ages for managed stands changed to minimum volume and diameter criteria only	—	—	-3
5.7	Landscape-level biodiversity — assuming no proportional representation	—	+5	+0.5
5.7	Landscape-level biodiversity — assuming old seral requirements in low BEO could be phased in over three rotations	—	+3	+0.4
5.7	Landscape-level biodiversity — assuming no mature seral forest retention requirement	—	—	—
5.7	Landscape-level biodiversity — old-growth order (combination of the three above)	—	+6	+2

(a) Impacts were rounded to the neared integer, except if the absolute value was 0.5 or less.

(b) In sensitivity analysis in which the assumptions have a positive impact on timber supply, a harvest flow choice was made not to increase the short-term harvest level above the base case short-term level. The increased timber supply was instead distributed toward mitigating the mid-term harvest decline, if possible. In some cases, therefore, the analysis results do not illustrate a short-term increase when one may have been possible under a different harvest flow choice.

(continued)

5 Timber Supply Sensitivity Analyses

Table 10. Summary of sensitivity analyses for the Revelstoke TSA, 2004 (concluded)

Report section	Description	Impact of sensitivity analysis assumptions relative to the base case timber supply (%)[a]		
		Short term[b]	Mid term	Long term
5.8	Caribou habitat – immature areas contribute to targets, full caribou guidelines apply to intermediate caribou habitat (S.A. 1)	—	—	-2
5.8	Caribou habitat — as S.A. #1, plus expand caribou habitat to all operable area in landscape units R6 and R14 and to ESSF operable area in R16. (S.A.2)	-5	-7	-3
5.8	Caribou habitat — apply increased seral retention (60% greater than 140 years in operable) to base case assumptions (S.A. 3a)	-16	-13	-13
5.8	Caribou habitat — apply increased seral retention (60% greater than 140 years in operable) to S.A. 1 (S.A. 3b)	-16	-13	-13
5.8	Caribou habitat — apply increased seral retention (60% greater than 140 years in operable) to S.A. 2 (S.A. 3c)	-22	-25	-22.5
5.8	Caribou habitat requirements not applied	—	+17	+15
5.9	Ungulate habitat — modifications to areas and to seral retention targets	—	—	+2
5.9	Ungulate habitat — modifications to seral retention targets; turn off moose heavy snowfall requirements	—	+0.5	+2
5.10	Combination run 1 – caribou S.A. 2 plus modified ungulate requirements	-5	-4.5	-2
5.10	Combination run 2 – caribou S.A. 3c plus modified ungulate requirements	-22	-23	-21
5.11	Increase allowable disturbance in visually sensitive areas	—	+8	+7
5.12	Assuming no natural disturbance in the non-contributing land base	—	+17	+24
5.12	Assuming half the base case level of disturbance in the non-contributing land base	—	+12	+11
5.13	Absolute oldest first harvest rule	—	—	-3
5.13	Absolute youngest first harvest rule	—	—	-0.1
5.13	Random harvest rule, spruce- and cedar-harvest priorities on	—	-2	—
5.13	Pure random harvest rule (spruce- and cedar-harvest priority off)	—	--4	-1
5.13	Removing priority on spruce- and cedar-leading stands	—	—	-1.5
5.14	Green-up age increased by 5 years — all zones	—	-0.5	-3
5.14	Green-up age decreased by 5 years — all zones	—	—	+2
5.15	Unsalvaged losses increased to 25 000 m^3/year	-5%	-8.5%	-10%

(a) Impacts were rounded to the nearest integer, except if the absolute value was 0.5 or less.

(b) In sensitivity analysis in which the assumptions have a positive impact on timber supply, a harvest flow choice is made to not increase the short-term harvest level above the base case short-term level. The increased timber supply is instead distributed toward mitigating the mid-term harvest decline, if possible. In some cases, therefore, the analysis results do not illustrate a short-term increase when one may have been possible under a different harvest flow choice.

6 Summary and Conclusions of the Timber Supply Analysis

The results of the 2004 timber supply analysis for the Revelstoke TSA suggest that, given data and assumptions that reflect our current level of understanding about forest management objectives and practices, the current allowable annual cut in the Revelstoke TSA of 230 000 cubic metres can be maintained for twenty years. After twenty years, the projected harvest level declines for the subsequent three decades by 10% per decade, and then by an additional 3%, before a mid-term harvest level of 165 000 cubic metres per year is attained. The harvest level then remains at that level until the 14th decade, when it increases by 3.2% to a long-term level of 170 500 cubic metres per year.

A series of sensitivity analyses illustrate that uncertainties in data or management practices can affect the timber supply projections to varying degrees. The resulting changes in assumptions can either increase or decrease available timber supply.

Factors affecting short-term timber supply

The base case illustrated a stable harvest in the short term, measured over the first twenty years of the analysis horizon, at the level of the current AAC. Other than in one alternative harvest flow in which an initial harvest level higher than in the base case was shown to be possible for one decade, increases in short-term timber supply relative to the base case were not attempted in the sensitivity analyses.

Analysis showed that uncertainties associated with three issues, the size of the timber harvesting land base, existing stand volume estimates and caribou management, could result in a reduction in short-term timber supply.

Decreasing the timber harvesting land base by 13%, to the size of the timber harvesting land base in the 1998 analysis, had an impact of about 14% on short-term timber supply. However, there is no data to suggest that the timber harvesting land base has been overestimated by this amount. Two sources of uncertainty do exist around the size of the timber harvesting land base: the merchantability of hemlock-leading stands, and a possible land base exclusion for a ski resort. Assuming that all sites currently occupied by stands comprised of more than 59% hemlock species were not harvestable (about 19% of the timber harvesting land base) would result in a 30% impact to short-term timber supply. If only those sites with stands of more than 79% hemlock species were not harvestable (about 5% of the timber harvesting land base), the timber supply reduction in the short term would be 14%. A smaller short-term impact would result if the Mount MacKenzie ski resort proposal area became unavailable to contribute to timber supply, which would reduce the size of the timber harvesting land base by about 2.5%. Short-term timber supply would be impacted by about 2.5% in this case.

If existing unmanaged stands had 10% less volume than in the base case, short-term timber supply is reduced by about 14%. While there is some uncertainty about volumes in existing stands, for example, related to estimates of losses to decay, there is no evidence to indicate that existing stand volumes are overestimated by 10%. This issue was examined primarily to inform decision-making about which factors are most important in defining timber supply.

Almost 45% of the timber harvesting land base is subject to requirements for caribou habitat management. The base case timber supply projection was unaffected by minor adjustments in the application of the caribou habitat guidelines. However, if management for caribou habitat were to apply to either a larger operable area or the requirements for mature forest cover were to increase, short-term timber supply could be significantly impacted. Short-term timber supply reductions ranged from about 5% if the operable area subject to management were increased, to 22% if this occurred in conjunction with increased retention of mature seral* forest. Relaxing the habitat management for moose and deer did not mitigate the short-term impacts.

All of the uncertainties examined above affected mid- and long-term timber supplies to varying degrees.

Mature seral
Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.

6 Summary and Conclusions of the Timber Supply Analysis

Factors affecting mid- and long-term timber supply

Some uncertainties did not affect short-term timber supply but did affect the mid-term supply.

Sensitivity analysis related to the following changes indicated substantial increases in mid-term timber supply relative to the base case: increases in the size of the timber harvesting land base; increases in estimates of volumes in unmanaged stands; application of old-growth order requirements for landscape-level biodiversity rather than the recommendations of the Minister's Advisory Committee; and reduction in the level of natural disturbance in the non-timber harvesting land base to about half of that in the base case.

Smaller but still significant increases could occur if old-growth site index adjustments accurately reflect future growth of managed stands, modifications were made to the application of landscape-level biodiversity requirements (i.e., phase in of old-seral requirements, no application of mature-seral requirements, or no proportional representation), or higher disturbance rates were acceptable in visually sensitive areas.

Uncertainties or changes that could result in lower mid-term timber supply include decreased merchantability of hemlock stands and modifications to caribou habitat requirements to cover larger areas or higher levels of retention.

7 Socio-Economic Analysis

The potential impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This section examines the socio-economic implications of the "base case" harvest forecast in the Revelstoke TSA. Base case harvest levels are those that can be sustained over time given the current forest management regime.[1] The analysis compares the level of forestry activity currently supported by the TSA timber harvest to the level of activity that could be supported as the Revelstoke timber supply approaches its long-term harvest level.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Socio-economic setting

7.1.1 Current population and demographic trends

The Revelstoke TSA is sparsely populated, with most of the population residing in the community of Revelstoke. In 2001, the Revelstoke TSA had a population of 8,062 (see Table 11), which reflects a decrease of almost 7% since 1996.

Forecasts for the Columbia-Shuswap Regional District, which includes the Revelstoke TSA, indicate a population increase of about 1.5%[2] by 2006. Whether this growth will occur in Revelstoke, however, is uncertain.

Table 11. Population statistics, Revelstoke TSA

Communities	Population 1996 census	Population 2001 census	% change 1996 – 2001
Revelstoke	8,047	7,500	– 6.8
Total — Revelstoke TSA	8,639	8,062	– 6.7

Source: BC STATS, with 1996 and 2001 Census data. Using 2001 Census geography.

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(1) The timber supply review and the socio-economic analysis do not consider the implications of changes in the resource management regime and land use.

(2) BC STATS, Population Section. Based on Revelstoke Local Health Area.

7.1.2 Economic profile

Current Economic Structure

Economic dependency estimates developed by BC STATS provide the best indication of the "basic" sectors that make up the structure of, and drive local economies.[3] As Figure 38 illustrates, the key sources of basic employment in the Columbia Forest District, of which the Revelstoke TSA is generally representative[4], are tourism, forestry, and the public sector (including education, health, and other federal, provincial and local public services).

Tourism-related employment, including accommodation, and parts of food, retail trade and other sectors, accounts for about 34% of total employment.[4] Forestry accounts for about 23%, and the public sector about 21%. Other sectors of current and historical importance to the local economy include rail and highway transportation, by virtue of Revelstoke's location on national east-west transportation routes.

Employment income is also a good indicator of a sector's contribution to the economy. For example, forestry employs 23% of basic employment and contributes 24% of basic income, indicating slightly higher than average income levels. Conversely, the public sector while employing 21% of basic employment contributes 17% of basic income, and the tourism sector, which employs 34% of basic employment, but only 15% of basic income.

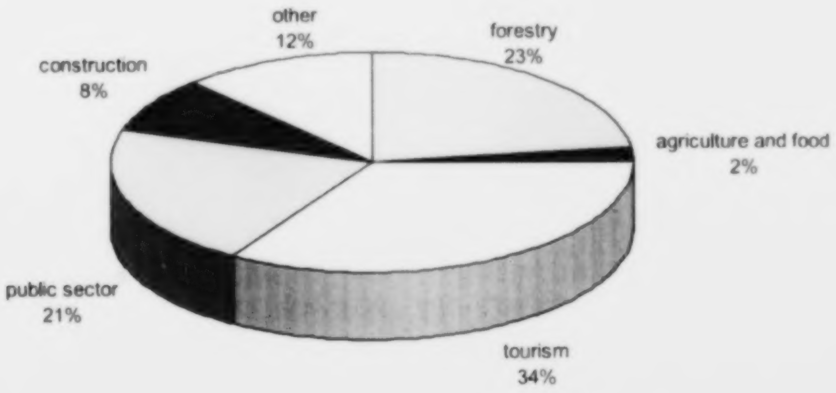

Figure 38. Basic sector employment, Columbia Forest District.

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(3) Basic sector employment is derived from, but is defined differently than labour force data. For example, basic employment excludes unemployed and includes both direct and indirect employment generated by basic sector companies purchasing inputs and other goods and services. The public sector is treated as a basic sector because the level of activity is largely determined by factors external to the local economy. See Horne, Garry. 2004. *British Columbia's Heartland At the Dawn of the 21st Century. 2001 Economic Dependencies and Impact Ratios for 63 Local Areas.* B.C. Ministry of Management Services.

(4) Horne, Garry. 2004. "2001 Economic Dependency Tables for Forest Districts", B.C. Ministry of Management Services. These figures are for the Columbia Forest District which includes the Revelstoke and Golden TSAs. The figures for the Columbia forest district were believed to reasonably represent conditions in the Revelstoke TSA based on comparisons of 1996 forest district tables, which showed that the Golden and Revelstoke TSAs were very similar in the make-up of their basic sector dependencies.

7.2 Revelstoke TSA forest industry

7.2.1 Current allowable annual cut and apportionment

The current allowable annual cut (AAC) for the Revelstoke TSA is 230 000 cubic metres, where it has been since 1995. The current AAC is apportioned to various types of licence, as summarized in Table 12.

Table 12. Allowable annual cut by licence type, Revelstoke TSA

Type of licence	Current AAC (cubic metres per year)	% of total
Forest licence	169 815	73.8
BC Timber Sales (BCTS)	42 933	18.7
TSL replaceable	12 597	5.48
Forest Service Reserve	4 600	2.0
Woodlot licence (unapportioned)	55	0.02
Total allowable annual cut	230 000	100.0

Source: Ministry of Forests, Resource Tenures and Engineering Branch.

7.2.2 Revelstoke TSA harvest history

Table 13 summarizes the volume of timber harvested in the Revelstoke TSA from 1998 to 2002.

While the AAC sets the maximum permissible harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. If actual annual harvest levels are consistently lower than the AAC, then forestry activity is below its full potential. The harvest statistics indicate that recent actual annual harvests in the TSA have been very close to the apportioned volume.

Table 13. Volume billed, by licence type, 1998-2002 (cubic metres), Revelstoke TSA[a]

Type of licence	1998	1999	2000	2001	2002	1998 – 2002 average
Forest licence	127 607	162 866	154 318	116 742	199 727	152 252
BC Timber Sales (BCTS)	39 130	68 041	24 779	11 626	27 115	34 138
TSL replaceable	20 273	25 545	5 342	143	7 469	11 754
Other[b]	37 762	33 073	28 705	25 225	20 475	29 048
Total harvest	224 772	289 525	213 143	153 735	254 785	227 192
Total allowable annual cut	230 000	230 000	230 000	230 000	230 000	230 000

Source: Ministry of Forests. Numbers may not add due to rounding.

(a) The table provides volumes of timber harvested from the Revelstoke TSA only. Timber harvested from tree farm licences and private land is not included.

(b) "Other" consists of cutting authorities such as rights-of-way, road permits and other small temporary permits.

7.2.3 Revelstoke TSA major licensees and processing facilities

There are three companies who hold replaceable forest licences in the Revelstoke TSA: Bell Pole Company with an AAC of 19 290 cubic metres, Joe Kozek Sawmills Ltd. with an AAC of 18 373 cubic metres, and Downie Street Sawmills Ltd. with an AAC of 132 152 cubic metres. Joe Kozek Sawmills also holds a replaceable timber sale licence in the TSA. From 2000 to 2002 each company harvested the majority of its allowable cut. See Table 14 for a summary of volumes billed for each licensee.

Table 14. Volumes billed by forest licence holder, 2000-2002, cubic metres[a]

	AAC	2000	2001	2002	Average
Bell Pole Company	19 290	17 525	26 305	8 535	17 455
Downie Street Sawmills Ltd.	132 152	134 601	94 088	190 787	139 825
Joe Kozek Sawmills Ltd.	18 373	19 278	17 408	14 074	16 929

(a) Volumes include cutting permits.

Each forest licence holder in the TSA also operates a processing facility. Downie Street Sawmills Ltd. operates the largest mill in Revelstoke with an annual capacity of approximately 75 million board feet of lumber. The Downie Street mill employs about 235 to 240 people. Downie Street Sawmills also operates Selkirk Specialty Wood Ltd. a local valued-added producer.

Joe Kozek Sawmills is a small lumber mill in Revelstoke with an annual capacity of about 15 million board feet. This mill employs about 30 people.

Bell Pole produces poles and the mill has the annual capacity to produce 20,000 pieces. The mill employs less than 10 people.

Two other smaller lumber mills operate in the Revelstoke TSA: Carl Beattie Cont. Ltd. and J.D. Mills Ltd.

From 2000 to 2002, the total volume of timber processed by all the mills operating in the Revelstoke area averaged about 330 000 cubic metres per year.

7.2.5 Forestry sector employment and employment coefficients

Employment coefficients* developed for the previous timber supply review analysis, expressed as full-time jobs or person-years of employment per 1000 cubic metres of harvest, are summarized in Table 13. TSA coefficients include residents of the Revelstoke TSA who are supported by timber harvesting and processing in the TSA. Provincial coefficients include all residents of the province that rely on the Revelstoke TSA timber supply, including those within the TSA.

Employment is divided into direct, indirect and induced components, the sum of which is the total impact. TSA level indirect and induced employment estimates were updated based on multipliers developed by BC STATS. See Appendix B for more information regarding employment coefficients and multipliers.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years

Table 15. Direct, indirect and induced employment and employment coefficients, Revelstoke TSA[a]

Forest industry activity	TSA employment (person-years)	TSA coefficients (person-years/ '000s m^3)	Provincial employment (person-years)	Provincial coefficients (person-years/ '000s m^3)
Harvesting	77	0.34	95	0.42
Silviculture	2	0.01	14	0.06
Processing	136	0.60	170	0.75
Total direct	215	0.95	279	1.23
Indirect + induced[b]	100	0.44	359	1.58
Total employment	315	1.39	638	2.81

(a) Employment estimates are reported in person-years. Coefficients are based on results of industry survey undertaken for the Revelstoke TSA Analysis Report (December, 1998). Employment estimates are based on an average 1998-2002 harvest of 227 192 cubic metres per year.

(b) Indirect and induced impacts for the TSA were updated based on Horne, G. 2004, "2001 Economic Dependency Table for Forest Districts". The indirect and induced coefficients reflect the mid-point of migration and no-migration TSA level multipliers for timber harvesting and processing. Provincial coefficients have not been changed and reflect data use in the Revelstoke TSA Analysis Report (December, 1998).

Based on data in Table 15, harvesting, silviculture and processing activities associated with the TSA harvest supported an estimated 215 person-years of direct employment in the TSA and a further 64 person-years of direct employment outside the TSA. Total employment within the TSA, including multiplier effects, is estimated at 315 person-years. Total provincial employment, including multiplier effects and TSA level employment, is estimated at 638 person-years.

7.2.6 Revelstoke TSA forestry employment income and government revenues

Currently, the average after-tax annual income for direct forestry employees is about $34,610 and indirect and induced average annual incomes, $24,730.[5] The Revelstoke TSA's timber harvest generates approximately $9.7 million in direct after-tax employment income and an additional $8.9 million of indirect and induced after-tax income.

Provincial government revenues from the forest industry related to harvest levels come from two main sources:

- stumpage, royalties and rent payments; and
- income taxes paid by those who are employed in the industry.

As shown in Table 16, between 1998 to 2002, the timber harvest in the Revelstoke TSA contributed an estimated $1.49 million in stumpage and related payments annually to the provincial government. In addition, the provincial government received approximately one-third of the $5.19 million in income taxes paid by forestry sector and related employees.

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(5) Horne, Garry. 2004. "2001 Economic Dependency Tables for Forest Districts". B.C. Ministry of Management Services.

Table 16. Estimate of provincial revenues, Revelstoke TSA, 1998-2002

	Estimated provincial revenues ($ million)	Provincial revenue ($ per '000s cubic metres)
Stumpage and related revenues[a]	1.49	6,570
Employment income taxes[b]	1.74	7,673
Total	3.23	14,243

(a) Ministry of Forests, Revenue Branch. Includes stumpage, royalties and rents.

(b) Canada Customs and Revenue Agency. Locality Code Statistics Tables. 2002 Edition (2000 Tax Year). www.ccra-adrc.gc.ca/tax/individuals/stats/gb00/pst/locsts/lsdown_by_prov-e.html. Final tax estimate based on specific average taxes paid within the Revelstoke census subdivision, CSD 5939019, and average tax rates for the province.

7.3. Socio-economic implications of the base case harvest forecast

The base case harvest flow projection indicates that the current AAC of 230 000 cubic metres can be maintained for 20 years. In the third decade, the timber supply is projected to decline to 207 500 cubic metres. This socio-economic analysis will focus on the initial 20-year period.

7.3.1 Employment, income and government revenue implications of base case harvest levels

The socio-economic analysis considers average levels of forest industry related activity that the base case forecast could support. Impacts associated with future projected harvest levels are calculated using employment, income and revenue coefficients (per 1000 cubic metres). This method assumes that the current role of the forest industry in the provincial economy and labour productivity will not change. For example, it is assumed that employment levels in the future can be predicted based on today's relationship between employment and the volume of timber harvested and processed. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment will remain constant and that the types and proportions of wood products manufactured will remain the same.

While this method is reasonably accurate for short-term forecasts (within the next five years), employment coefficients 20 years from now may differ as a result of changes in market conditions, timber-processing technologies, etc. The analysis indicates the magnitude of impacts to employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

Revelstoke TSA socio-economic assessment

Based on the timber supply analysis, the timber supply will remain stable for two decades. Given favourable market and other trade considerations, this means that employment and incomes dependent on the TSA will remain a source of stability for local communities. See Table 17.

Table 17. Revelstoke TSA socio-economic impacts of base case harvest forecast

	Economic impact of current harvest level	Potential economic impact of projected timber supply[a]	
		Decades 1-2 (current AAC)	Decade 3
Current AAC / future timber supply	230 000	230 000	207 500
Current harvest level (1998-2002 average)	227 192	N/A	N/A
Difference from current AAC	2 808		
Revelstoke TSA			
Employment		**(person-years)**	
Direct	215	219	197
Indirect + Induced	100	101	91
Total	315	320	288
Range of employment gain (loss) from current harvest level		5	(27)
Employment Income		**($2001 million per year)**	
Direct	7.47	7.56	6.82
Indirect + Induced	2.47	2.50	2.25
Total	9.94	10.06	9.07
Province[b]			
Employment		**(person-years)**	
Direct	279	283	255
Indirect + Induced	359	363	328
Total	638	646	583
Range of employment gain (loss) from current harvest level		8	(55)
Employment Income		**($2001 million per year)**	
Direct	9.67	9.79	8.83
Indirect + Induced	8.88	8.99	8.11
Total	18.55	18.78	16.94
Provincial government revenues		**($2001 million per year)**	
Stumpage and related payments	1.49	1.51	1.36
Employee income taxes	1.74	1.76	1.59
Total	3.23	3.27	2.95

(a) Assumes market, technology and other factors will permit harvest and use of currently unutilized timber (i.e., the difference between the AAC and the average harvest.

(b) TSA employment and income estimates are included in the provincial employment and income estimates. All estimates based on data in Sections 7.2.5 and 7.2.6.

Provincial socio-economic assessment

Provincial employment includes all forestry sector employment supported by the timber harvested from the Revelstoke TSA, including employment within the TSA. No employment impacts associated with changes to timber supply are expected during the initial two decades given the stability of the harvest forecast.

In the initial two decades, the base case timber supply forecast for the Revelstoke TSA would not result in any reduction in provincial revenues, if existing stumpage and income tax rates do not change.

7.3.2 Implications for processing facilities in the Revelstoke TSA

Revelstoke TSA mills process approximately 330 000 cubic metres of timber annually. The TSA harvest accounts for about 69% of this volume processed. The remainder comes from adjacent TSAs and TFLs. This means that processing facilities and communities within the Revelstoke TSA can be affected by timber supply changes in other areas.

The stable timber supply for the next two decades will help to maintain current activity. However, after the initial two decades, the declining timber supply may combine with declines in other management units to place some processing facilities at risk. Information from timber supply reviews for other TSAs in the east Kootenay area indicates that timber supplies in the region will likely decline within 10 to 15 years.[6]

7.3.3 Community impacts

The Revelstoke TSA relies on the forest industry for a substantial portion of its economic activity. The base case timber supply projection indicates that the forestry sector can maintain its current contribution to the TSA's economy.

7.4 Summary

The forest industry is the largest private sector source of basic income in the Revelstoke TSA economy.

Within the Revelstoke TSA, the current level of harvesting supports an estimated 315 person-years of employment annually (includes direct, indirect and induced jobs*) and $9.94 million in employment income. Provincially, the harvest from the Revelstoke TSA supports 638 full-time jobs, $18.55 million in employment income and $3.23 million in gross provincial revenues.

The base case harvest forecast for the Revelstoke TSA indicates a stable timber supply for the first 20 years, with reductions starting in decade 3. Assuming existing harvesting and milling productivities do not change, the current average employment and income levels will remain about the same, with variations in annual employment as a result of fluctuating harvest levels.

The stability in timber supplies for the first two decades should also provide sufficient time for other sectors to respond, providing greater economic diversification and stability.

Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

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[6] Based on TSR 2 analyses for the Cranbrook, Invermere, and Revelstoke TSAs, including the implications of the Kootenay-Boundary Land Use Plan.

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Available volume	The portion of total inventory volumes that is available for harvesting after all management constraints on timber harvesting have been considered, including definition of the timber harvesting land base, age of tree merchantability, deferrals, and any other priorities or constraints on timber harvesting.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcut harvesting	A harvesting method in which most trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.

9 Glossary

Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

9 Glossary

Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Mature seral	Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.

9 Glossary

Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.
Minimum harvestable age	The age at which a stand of trees is expected to achieve a merchantable condition. The minimum harvestable age could be defined based on maximize average productivity (culmination of mean annual increment), minimum stand volume, or product objectives (usually related to average tree diameter).
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Modification VQO	Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity (see **Visual quality objective**).
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

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Partial retention VQO	Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

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Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

This appendix outlines the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Revelstoke TSA timber supply analysis. This information represents current forest management in the area.

Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced, are not included in this appendix.

The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any future changes in forest management objectives and practices, and any improvements to the data will be incorporated into future timber supply reviews.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Source scale
Revelstoke TSA forest cover FC1 and FIP files	Ministry of Forests (MoF) standard inventory files	2000	1:20,000
Federal (National) park forest cover	MoF Nelson Region files	1956	1:32,000
Operability	MoF non-standard inventory files	2001	1:20,000
Biogeoclimatic zones (including natural disturbance types)	MoF standard inventory files	1999	1:20,000
Caribou habitat	MoF District non-standard inventory files	1995	1:250,000
Ungulate winter habitat (non-caribou)	MoF District non-standard inventory files	1997	1:250,000 (some digitizing done from 1:20,000 contour)
Draft landscape unit boundaries	MoF District non-standard inventory files	2001	1:250,000
Visual landscape inventory	MoF District non-standard inventory files	2001	1:50,000
Connectivity corridors for biodiversity	MoF District non-standard inventory files	1997	1:50,000
Timber licence areas	MoF standard inventory files	1991/92	1:20,000
Land ownership	MoF standard inventory files	1991/92	1:20,000
Watershed atlas (includes community and domestic watersheds)	MoF Nelson non-standard Region files	2001	1:20,000
Environmentally sensitive areas (ESA)	MoF District non-standard coverage	10/1994	1:20,000
Blocks harvested since 2000 (2001 Forest Development Plan)	MoF District non-standard files	12/2001	1:20,000
Category A blocks in 2001 Forest Development Plan	MoF District non-standard files	12/2001	1:20,000
Slope – 60% and 80% line derived from TRIM Grid	MoF District non-standard	04/2002	1:20,000
Roads	MoF District non-standard files	12/1998	1:20,000
Stream classes	MSRM Nelson watershed atlas data transferred to TRIM base	05/2002	1:20,000

A.1 Inventory Information

Data source and comments:

Forest cover:

NAD 83 mapsheets that are based on August 1992 air photography for the northern part of the district and September 1991 air photography for the southern part of the district covers the Columbia Forest District. They have been updated for harvesting and silviculture activities to October of 1999.

Federal (National) park forest cover:

Forest cover information for parks does not contribute to the harvest forecasts. Forested area in parks is normally included in timber supply analyses since it contributes to biodiversity requirements. However, due to the implementation of forest cover requirements in the Revelstoke TSA according to the Revelstoke and Area Minister's Advisory Committee (MAC) recommendations, inclusion of the parks would have no impact on the timber supply forecast. Therefore, the forested park area was not included in the analysis. The most significant reason for the lack of impact is that under the MAC recommendations, specified amounts of old and mature forest should be reserved on the Crown productive forest land base both above and below the operability line (i.e., proportional representation). The operability classification does not apply in the parks, and therefore the parks do not contribute to seral requirements below the operability line. Since the forest cover requirements below the operability line affect timber supply, and those above the line do not (at least while the existing operability line is in place), the parks would not affect analysis results.

Operability:

Operability lines were revised in 2001.

Biogeoclimatic subzones and natural disturbance types:

The biogeoclimatic inventory was completed in 1999. Natural disturbance types have been derived from the biogeoclimatic classification.

Caribou habitat:

The caribou habitat maps that were initially developed by the Ministry of Environment, Lands and Parks (MELP) in June 1995 have been revised through the radio telemetry work done by Bruce McLellan and John Flaa in 1996. The revised maps identify a caribou line, caribou habitat to be managed to caribou forest cover guidelines, caribou habitat to be managed to intermediate biodiversity seral requirements and caribou habitat containing immature stands.

Ungulate winter habitat:

This non-standard overlay identifies important winter habitats for moose and mule deer. Boundaries were based on elevation bands and the professional judgment of district and the former regional Ministry of Environment, Lands and Parks staff (now MSRM or MWLAP).

Draft landscape unit boundaries:

Landscape unit boundaries were proposed in 1995. The draft landscape unit boundaries have been revised since the last timber supply review to follow the management unit boundaries between the Timber Supply Area and Tree Farm Licence Areas. Landscape unit boundaries and objectives have not been legally established by the district manager but reference has been made to them in the last set of development plan directions approved by the district manager.

Visual landscape inventory:

Visual landscape units with objectives have been established which reflect the MAC strategy.

A.1 Inventory Information

Connectivity corridors:

The district forest and environment staff developed this non-standard layer in 1995 for implementation of high and intermediate biodiversity emphasis in the district. Based on this about 16% of the TSA is assigned to a high emphasis biodiversity option and 16% to an intermediate, leaving potentially 68% for low emphasis. However, about 20% of the TSA that is in low emphasis areas is also managed according to caribou habitat guidelines stringent enough to meet intermediate emphasis biodiversity requirements. Thus, intermediate biodiversity requirements effectively apply on 36% of the TSA when caribou habitat management is taken into account. In the Revelstoke TSA biodiversity emphasis management is being implemented through a corridor method rather than via landscape units. Generally, the high emphasis corridors are oriented in a north-south direction along Lake Revelstoke and Upper Arrow Lake. The intermediate corridors extend in an east-west direction along the Downie, Goldstream, and Kirbyville drainages. The district manager has not legally established biodiversity emphasis objectives.

Land ownership:

Land ownership files have been updated to include new woodlot licences and deletions of timber licences.

Watershed atlas:

This non-standard layer contains streams, wetlands and lakes. It was the source for determining areas in riparian reserve zones. This overlay also contains the boundaries of community and domestic watersheds. The following are considered community watersheds: Greely Creek, Hamilton Creek, Bridge Creek and Dolan Creek. Domestic watersheds are also considered in areas adjacent to the City of Revelstoke.

Environmentally sensitive areas:

The environmentally sensitive area classification was taken from the FC1 files.

2001 Forest Development Plan:

The 2001 Forest Development Plan maps provide the following information:

- blocks harvested since 2000;
- category A blocks;
- category A blocks on Timber Licences.

60 and 80% slope:

Slopes were generated from (TRIM) elevational data in 20 metre contours.

Roads:

The roads are based on TRIM data.

A.2 Zone and Analysis Unit Definitions

A.2.1 Management zones and tracking of multiple objectives (groupings)

Multiple objectives are tracked on the forested land base in the timber supply analysis. These objectives are described in Table A-2. below. Table A-3. shows the areas both inside and outside the timber harvesting land base for each management zone within each landscape unit. Table A-4. shows the landscape units in the Revelstoke area.

Table A-2. Objectives tracked

Objectives	Inventory definition
Landscape-level biodiversity	Biodiversity emphasis option (BEO) targets for old and old plus mature seral stages within landscape units and corridors.
Full caribou management	Age class 8 and 9 area targets specified for the ESSF and ICH biogeoclimatic zones within identified caribou areas above and below the Caribou line having slopes less than 80%.
Intermediate caribou management	Intermediate BEO targets applied to Caribou habitat as specified in the MAC strategy.
Ungulate winter range (UWR) habitat cover requirements	Forest cover constraints within ungulate winter range.
Community and domestic watershed management	Green-up requirements in community and domestic watersheds.
Visual quality management	Green-up requirements in visual landscape units, which reflect the visual classes in the MAC strategy.
Integrated resource management	Green-up requirements in areas where harvesting operations are not constrained by other management objectives (except biodiversity).

A.2 Zone and Analysis Unit Definitions

Table A-3. Areas by management zone

Zone	Landscape unit	Non-timber harvesting land base		Timber harvesting land base (ha)	Total Crown productive forest (ha)
		Inoperable (ha)	Operable but excluded (ha)		
Community watersheds					
	R7	62	21	240	
	R20	2 609	2	14	
Totals		2 671	23	254	2 948
Domestic watersheds					
	R2		21	301	
	R3	1 601	918	2 961	
	R7	350	202	568	
	R8	557	81	624	
	R10	87	0	0	
	R20	401	139	636	
Totals		2 996	1 361	5 090	9 447
Visual quality objectives					
Modification	R3	3 028	1 598	7 070	
	R7	1 840	162	986	
	R8	891	29	349	
	R10	466	245	627	
	R20	719	15	4	
	Totals	6 944	2 049	9 036	18 029
Partial retention	R3	219	533	1 301	
	R7	303	352	2 173	
	R8	424	187	1 310	
	R20	5 681	645	3 323	
	Totals	6 627	1 717	8 107	16 451
Retention	R3		1	29	
	R7	1 365	180	321	
	R20	2 282	369	1 009	
	Totals	3 647	550	1 359	5 556
VQO totals					40 036

Note: blank cells denote no area.

(continued)

A.2 Zone and Analysis Unit Definitions

Table A-3. Areas by management zone

Zone	Landscape unit	Non-timber harvesting land base		Timber harvesting land base (ha)	Total Crown productive forest (ha)
		Inoperable (ha)	Operable but excluded (ha)		
Caribou					
	R6	885	18	132	
	R7	1 492	54	370	
	R8	5 000	582	5 310	
	R10	8 315	952	5 875	
	R11	860	283	1 761	
	R12		10	235	
	R14	6 184	887	10 570	
	R15	2 966	250	3 327	
	R16	1 974	249	3 903	
	R17	1	28	303	
	R18	127	9	101	
	R19	204	7	92	
	R20	5 196	625	3 071	
Caribou totals		33 204	3 954	35 050	72208
Deer and Moose					
Deer	R2		141	226	
	R3	569	1 144	3 310	
	R4		7	31	
	R7	146	272	1 322	
	R8	137	117	579	
	R10	526	309	1 598	
	R20	299	100	291	
Deer totals		1 677	2 090	7 357	11124
Moose	R6	153	64	1 467	
	R7	209	236	867	
	R8	36	399	2 508	
	R11	196	225	1 212	
	R12		7	187	
	R14	391	289	3 902	
	R15	243	177	1 419	
	R16	500	182	2 201	
	R17	1	28	290	
	R18	130	198	784	
	R19	158	6	82	
Moose totals		2 017	1 811	14 919	18 747

Note: blank cells denote no area.

(continued)

A.2 Zone and Analysis Unit Definitions

Table A-3. Areas by management zone

Zone	Landscape unit	Non-timber harvesting land base		Timber harvesting land base (ha)	Total Crown productive forest (ha)
		Inoperable (ha)	Operable but excluded (ha)		
Biogeoclimatic					
ESSF vc	R7	6 025	153	588	
	R8	4 810	106	810	
	R10	9 136	260	1 742	
	R11	3 107	56	503	
	R14	8 403	323	2 918	
	R15	10 945	92	655	
	R16	11 798	293	2 663	
	R18	8 135	53	813	
	R20	6 340	96	338	
ESSF vcp	R7	14			
	R8	118			
	R10	491			
	R11	203			
	R14	340			
	R15	194			
	R16	402			
	R18	689		22	
	R20	214			
ESSF wc 1	R1	80	48	281	
	R2			3	
	R3	2 321	375	1 451	
	R7	679	2	5	
	R20	2 516	85	639	
ESSF wc 2	R6	2 314	131	1 240	
ESSF wc 4	R1	114	22	347	
	R2			3	
	R3	5 213	204	832	
	R7	334			
	R20	4 700	40	666	
ESSF wcp 2	R6	149	2		
Total ESSF		89 784	2 341	16 519	**108 644**

Note: blank cells denote no area.

(continued)

A.2 Zone and Analysis Unit Definitions

Table A-3. Areas by management zone (concluded)

Zone	Landscape unit	Non-timber harvesting land base		Timber harvesting land base (ha)	Total Crown productive forest (ha)
		Inoperable (ha)	Operable but excluded (ha)		
ICH mw 2	R3	316	709	3 510	
ICH mw 3	R2		150	328	
	R3	448	951	2 566	
	R4		7	31	
	R7	477	393	1 602	
	R8	132	49	141	
	R10	1 684	271	1 451	
	R12		7	178	
	R14			2	
	R19	14	2	60	
	R20	454	181	506	
ICH vk 1	R3	1 566	718	1 648	
	R6	1 322	150	3 880	
	R7	1 234	171	1 084	
	R8	478	52	487	
	R10	1 410	126	1 639	
	R11	1 673	129	1 110	
	R14	1 462	447	4 789	
	R15	3 134	424	3 589	
	R16	3 024	408	5 446	
	R17	1	28	303	
	R18	4 194	325	2 843	
	R20	3 008	366	2 012	
ICH wk 1	R1	31	109	1 523	
	R2	89	20	385	
	R3	1 600	671	2 125	
	R6	50	6	143	
	R7	1 365	522	2 505	
	R8	428	620	4 503	
	R10	1 809	360	1 504	
	R11	1 175	325	1 771	
	R12		4	57	
	R14	605	341	4 103	
	R15	772	85	693	
	R16	98	22	381	
	R19	193	5	32	
	R20	5 347	892	3 668	
Total ICH		39 593	10 046	62 598	112 237
Total Biogeoclimatic[a]					220 881

(a) The "Total Biogeoclimatic" area is the total Crown productive forest area. It excludes existing roads (1810 hectares) and non-commercial cover (113 hectares).

A.2 Zone and Analysis Unit Definitions

Table A-4. Revelstoke area landscape units

Landscape unit number	Landscape unit name	Productive forest (hectares)	Timber harvesting land base[a] (hectares)
R1	Pingston	2 554	2 151
R2	Cranberry	979	719
R3	Akolkolex	27 247	12 155
R4	Mulvehill	38	31
R5	French	—	—
R6	Red Rock	9 387	5 263
R7	Jordan	17 154	5 784
R8	Frisby Ridge	12 733	5 940
R9	Lake Revelstoke	—	—
R10	LaForme	21 882	6 335
R11	Big Eddy	10 052	3 384
R12	Downie	245	235
R14	Liberty	23 732	11 811
R15	Horne	20 583	4 937
R16	Soards	24 533	8 490
R17	Mica	333	303
R18	Big Mouth	17 073	3 677
R19	Goldstream	306	92
R20	Illecillewaet	32 068	7 828
Totals		**220 899**	**79 135**

(a) These areas include Timber Licences that are added to the land base during the analysis horizon (a total of 1117 hectares), and excludes existing roads (1810 hectares) and non-commercial cover (113 hectares).

A.2 Zone and Analysis Unit Definitions

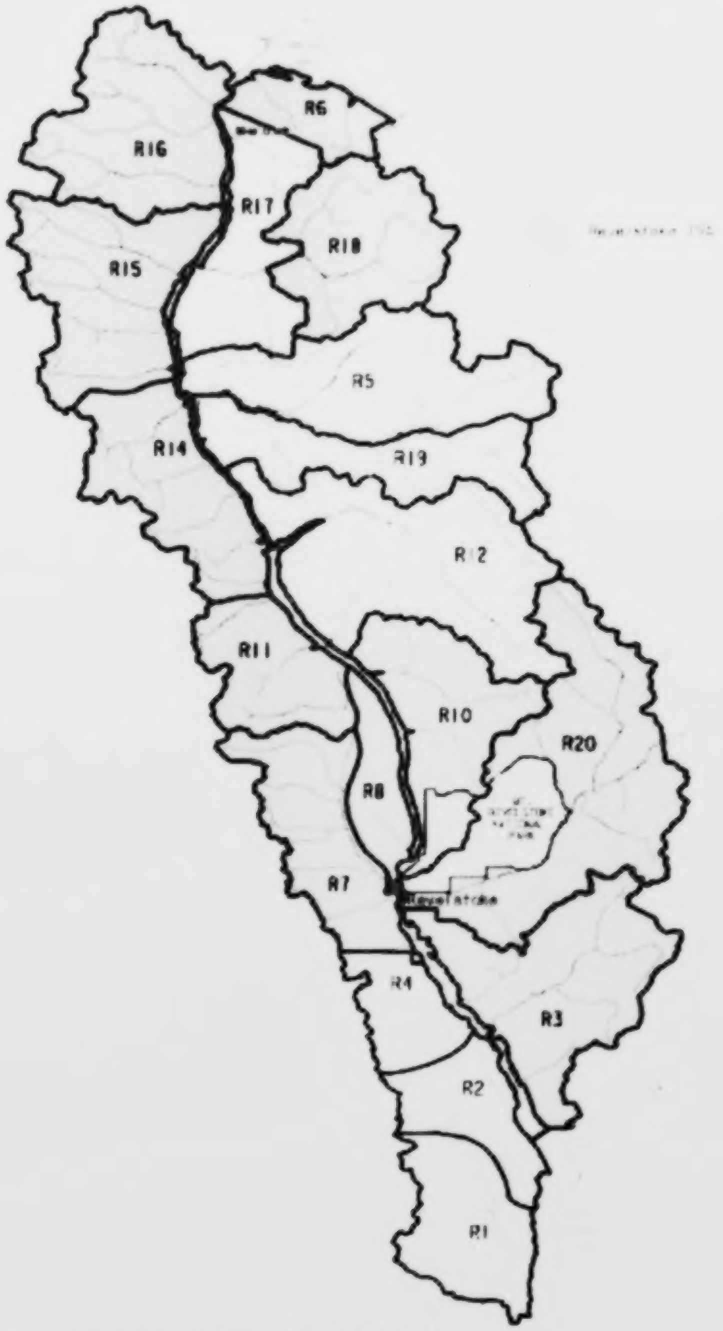
R16
R6
R17
R18
R15
R5
R14
R19
R12
R11
R10
R20
R8
R7
Revelstoke
R4
R3
R2
R1

Figure A-1. Landscape units in the Revelstoke TSA.
(see previous page for identification of landscape unit names)

A.2 Zone and Analysis Unit Definitions

A.2.2 Analysis units

An analysis unit represents a group of stands dominated by specific tree species having a specific timber growing capability — as indicated by the inventory type group and site index in the forest inventory file. Each analysis unit is assigned its own timber volume projections (yield tables). Timber volume projections are made for each group of stands within an analysis unit having the same status. A stand's status may be the following:

- Natural — existing stand older than 25 years managed under a clearcutting regime, or the coniferous understory component of a deciduous-leading stand age 25 years or younger.
- Managed — existing stand 25 years or younger (recent plantation), or a future non-backlog stand, managed under either a clearcutting or partial cutting regime.
- Backlog 1 — land currently classified as backlog meeting 60% or more of the minimum stocking standard, managed as a low volume natural stand (backlog rule).
- Backlog 2 — land currently classified as backlog meeting less than 60% of the minimum stocking standard, managed as a low volume natural stand.

Yield tables for all but managed stands were derived using the variable density yield projection (VDYP) growth and yield model, version 6.5a. Yield tables for managed stands were derived using the table interpolation program for stand yields (TIPSY).

A stand was assigned an analysis unit number and a yield table number for grouping purposes. The following table shows the coding scheme for deriving these numbers.

Table A-5. Coding scheme for analysis unit and yield table numbers[a]

Stand status code and description	Species group code and description	Site group code and description
0 — old natural, existing ≥ 140 years (VDYP)	1 — fir leading	1 — good
1 — natural, existing > 25 years (VDYP) but < 140 years	2 — cedar leading	2 — medium
2 — managed, existing ≤ 25 years (plantations) and future regenerated (TIPSY)	3 — hemlock leading	3 — poor
4 — backlog 2, < 60% MSS[b] (VDYP)	4 — balsam, spruce predominant	4 — all, or medium & poor
5 — backlog 1, ≥ 60% MSS[b] (VDYP)	5 — spruce mixed	
	6 — other	

(a) The codes in the three columns categorize separate stand characteristics, and hence are mutually exclusive. For example, using the coding scheme, an old-growth (more than 140 years of age) fir-leading stand growing on a good site would be assigned to analysis unit number 011. If that stand is of natural origin and between the ages of 25 and 140 years, it would be assigned yield table number 111. If that stand is managed it would be assigned yield table number 211, etc. In the analysis, if there were small amounts of area in some analysis units, the analysis units were combined.

(b) MSS = minimum stocking standard

A.2 Zone and Analysis Unit Definitions

Table A-6. Definition of analysis units

Species group code[a]	Site index group[b] (metres @ 50 years)	Analysis unit number[c]	Inventory type groups
F, L, P	> 21	011, 111, 211	F, F&Pl, F&Py, F&L, F&Decid, L&F, L, Pw&Pa, Pl, Pl&F, Pl&S, Pl&Decid, Py (1- 5, 6, 7, 8, 27, 28, 29, 30, 31, 32, 33, 34)
	> 15 to < 21	012, 112, 212	
	< 15	013, 113, 213	
C	≥ 17.5	021, 121, 221	C, C&F, C&H, C&S (9, 10, 11)
	≥ 14.5 to <17.5	022, 122, 222	
	< 14.5	023, 123. 223	
H	≥ 18	031, 131, 231	H, H&F, H&C, H&B, H&S, H&Decid (12, 13, 14, 15, 16, 17)
	≥ 12 to < 18	032, 132, 232	
	< 12	033, 133, 233	
B, S (where dominant)	≥ 18	041, 141, 242	B, B&H, B&S, S, S&B (18, 19, 20, 21, 24)
	> 13 to < 19	042, 142, 242	
	< 13	043, 143, 243	
S (mixed)	≥ 18	051, 151, 251	S&F, S&H, S&Pl, S&Decid (22, 23, 25, 26)
	≥ 14 to < 18	052, 152, 252	
	< 14	053, 153, 253	
Deciduous[d]	All	264	Cot&Conif, Cot&Decid, Bi, A&Conif, A&Decid (35, 36, 40, 41, 42)

(a) Codes taken from the Vegetation Resources Inventory, B.C. Land Cover Classification Scheme Document.

(b) The low site definition sets the lower site index limit for each species group (see Table A-9).

(c) Using the coding scheme, an old growth (more than 140 years of age) fir-leading stand growing on a good site would be assigned to analysis unit number 011. If that stand is of natural origin and between the ages of 25 and 140 years, it would be assigned yield table number 111. If that stand is managed it would be assigned yield table number 211, etc. In the analysis, if there were small amounts of area in some analysis units, the analysis units were combined.

(d) All but 145 hectares of deciduous-leading were excluded in the derivation of the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Identification of the timber harvesting land base

This section outlines the steps used to identify the timber harvesting land base (the productive forest expected to support timber harvesting) within the timber supply area. The timber harvesting land base for the Revelstoke TSA was determined by identifying types of forest and land which do not contribute to timber harvesting in the TSA. Land may be unavailable for timber harvesting for three principal reasons:

- it is not administered by the British Columbia Forest Service for timber supply purposes (e.g., private land, parks, etc.);
- it is not suitable for timber production purposes; or
- it is required for other forest values.

Land may also be added to the timber harvesting land base as a result of the following:

- management activities which improve productivity or operability (e.g., the stocking of land currently classified as non-commercial brush);
- the acquisition of productive forest land (e.g., timber licence reversions).

After all areas that do not contribute to the timber harvesting land base have been identified, any additional areas are added to the land base. The resulting land base is defined as the "current timber harvesting land base" for the TSA.

A.3.2 Details on land base classification

A.3.2.1 Land not administered by the British Columbia Forest Service for timber supply purposes

Ownership codes are generally used to identify whether the land can be considered to contribute to timber supply. Ownership codes 62C and 69C indicate Crown land in a forest management unit and miscellaneous reserves respectively. These are generally the only ownership codes which are considered to contribute to timber supply. Timber licence area — ownership code 70N, is considered under Section A.3.2.13, "Timber licence reversions."

A.3.2.2 Land classified as non-forest

Areas such as alpine area, lakes, or rock are removed from the land base considered for timber supply.

A.3.3.3 Non-commercial cover

Areas where the inventory shows non-commercial brush species growing. These areas are considered to be unlikely sites for timber production.

A.3.3.4 Areas considered inoperable

Operability and inoperability codes are generally used to describe the presence or absence of physical barriers or limitations to harvesting, applicable logging methods (e.g., cable), and the merchantability of stands.

A.3 Definition of the Timber Harvesting Land Base

Table A-7. Description of inoperable areas

Inventory description	Operability code	Reduction per cent (%)
Conventional harvesting practices	A	0
Inoperable areas	I	100

Data source and comments:

TSR 2 used the 1997 operability line. As a result of a review of this line during the TSR 2 process a revised 1999 operability line was established which further reduced the 1997 operable land base. The operability was then reviewed again in 2001 / 2002, and this line was used in this analysis. The review resulted in further reductions in the operable land base primarily due to exclusion of marginal stands and problem forest types.

A.3.2.5 Environmentally sensitive areas

The ESA system uses the following classification: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh) and fisheries (fisheries symbols). With the exception of avalanche and fisheries, two ESA categories are recognized: high and moderately sensitive.

In the Revelstoke TSA analysis, ESA reductions were made only for avalanche and sensitive soils. All avalanche areas were excluded from the timber harvesting land base. No reductions were made for areas with moderately sensitive soils. For highly sensitive soils areas, slope was used as the basis for land reductions. Sensitive soils on slopes greater than or equal to 60% were completely excluded. On slopes less than 60%, only 25% of the sensitive soil areas were excluded from the timber harvesting land base.

Table A-8. Description of environmentally sensitive areas

ESA category	ESA description	Slope	Reduction per cent (%)
A,AR,AP	Avalanche	All	100
S, SA, SAP,SAR, SH, SHR, SP, SPR, SR, SRW,SW	Soil	=> 60%	100
S, SA, SAP,SAR, SH, SHR, SP, SPR, SR, SRW,SW	Soil	< 60%	25

Data source and comments:

There were no ESA reductions for plantations (Ep) because of improvements in site preparation and planting stock. There were no ESA reductions for wildlife because forest cover modelling guidelines are used to reflect management in ungulate and Caribou habitats. Watershed ESA reductions were not felt necessary because of *Forest Practice Code* riparian requirements, and because domestic and community watershed constraints were modelled in the analysis. Recreation ESA reductions were not done because of the application of visual quality modelling guidelines in areas along the Trans-Canada highway and in areas that can be viewed from the city of Revelstoke. Terrain hazard mapping was not in a format that could be incorporated into the TSR planning file.

A.3.2.6 Sites with low timber growing potential

Sites may have low productivity because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.). As these stands are not considered to be harvestable, they need to be identified and excluded from consideration for the timber harvesting land base.

Table A-9. Description of sites with low timber growing potential

Leading species	**Tree genus or species code[a]**	**Inventory type groups**	**Site index (m @ 50 years)**	**Reduction per cent (%)**
Douglas-fir	F	1, 2, 3, 4, 5, 6, 7, 8	< 9	100
Cedar	C	9, 10, 11	< 9	100
Hemlock	H	12,13,14,15,16,17	< 8	100
Balsam	B	18, 19	< 8	100
Spruce	S	20, 21, 22, 23, 24, 25, 26	< 8	100
White pine	Pw	27	< 8	100
Interior lodgepole pine	Pli	28, 29, 30, 31	< 9	100
Ponderosa pine	Py	32	< 9	100
Larch	L	33, 34	< 9	100
Deciduous[b]	Any deciduous	35, 36, 37, 38, 39, 40, 41, 42	< 9	100

(a) Codes taken from the Vegetation Resources Inventory *B.C. Land Cover Classification Scheme* Document — Section 1 Table 6.2

(b) Most deciduous types (age > 25 years) of all site indices are excluded from the timber harvesting land base (see Section A.3.2.7).

A.3.2.7 Problem forest types

Problem forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. The types identified in Table A-10 were excluded from the timber harvesting land base.

Table A-10. Problem forest type criteria

Inventory type groups	Age (years)	Reduction per cent (%)
H&Dec (17)	> 140	100
Cot&Conifer, Cot&Decid, D&Conif, D&Decid, Mb, Bi, A&Conifer, A&Decid (35, 36, 37, 38, 39, 40, 41, 42)	> 25	100

Data source and comments:

The new 2002 operability information excluded most hemlock-leading stands older than 140 years of age. Analysis showed harvesting performance in stands containing a high composition of hemlock was comparable to the percentage contribution of those stands to the newly defined operable land base. Hence, harvesting performance indicated that no further netdown factors for hemlock- and balsam-leading stands were warranted, other than the one above for hemlock deciduous stands.

For the purposes of this analysis, only coniferous-leading stands are considered merchantable. The deciduous (hardwood) component of the forest can occur as relatively minor components of stands of mixed-coniferous/deciduous species, and as predominantly deciduous stands. Inventory type groups 35 to 42 identify stands dominated by deciduous species, with a smaller proportion of coniferous trees. Stands of these types older than 25 years of age were excluded from the timber harvesting land base, as there is very little harvesting of these types. In the analysis, deciduous stands less than 25 years of age were assumed to be treated to become coniferous-leading stands over time.

A.3.2.8 Roads, trails and landings

Estimates were made to reflect the loss in productive forest land due to both existing and future roads, trails and landings (RTLs). Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting, and future RTL reductions are applied after stands are harvested for the first time in the simulation model.

Table A-11. Estimates for permanent existing and future roads

	Age (years)	Right-of-way width (metres)	Reduction (hectares or per cent)
Existing RTLs			
Secondary roads	N/A	17	1146 ha
Landings, trails and deactivated roads	≤ 25	N/A	3% (664 ha)
Future RTLs	> 25	N/A	6% (2898 ha)

Data source and comments:

Existing roads have been captured in a district non-standard overlay. This overlay captures roads from forest cover data that has been updated to October of 1999. Three classes of roads have been defined. Class 1 designates highways and secondary roads. Most of these have been identified as non-forest in the inventory and are not part of the productive land base, so no netdown was applied. Class 2 roads designate logging roads. A 17-metre road right-of-way buffer was applied to these roads. Class 3 roads are trails or deactivated roads. A 3% reduction was applied to stands 25 years of age or less to account for landings, trails and deactivated roads.

To determine the appropriate reduction to account for future roads, trails and landings, ISIS data was examined. ISIS shows that the amount of area lost to permanent access on average over the past 5 years was about 6% in each treatment unit. It is assumed this trend will continue into the future, and thus a 6% land base reduction was applied to areas as the stands occupying them were harvested for the first time only.

A.3.2.9 Wildlife habitat reductions

In the *Managing Identified Wildlife Guidebook*, management prescriptions include core "no harvesting" areas around nesting sites or other valuable habitats for endangered species.

The Identified Wildlife Management Strategy (IWMS) Version 2004 was released in June 2004 and replaces IWMS Volume 1, released in 1999. No wildlife habitat areas have been proposed in the Revelstoke TSA. No specific accounting for identified wildlife was made in the timber supply analysis.

A.3.2.10 Cultural heritage resource reductions

Cultural heritage values include traplines, and sites of archaeological or traditional use.

There were no explicit exclusions in the analysis to account for identified cultural heritage resources. An archaeological overview assessment has not been conducted for the Revelstoke TSA.

A.3.2.11 Riparian management areas

The *Forest Practices Code* requires that riparian reserves and management zones be left along a number of lakes, wetlands and streams. The riparian reserve and management zone width is based on the streams, wetland or lakes classification. Much of this classification has taken place for forest development planning purposes.

Stream class information from MSRM Nelson watershed atlas data was transferred to a TRIM base. A total of 2758 hectares were identified as riparian buffer areas, and 1317 hectares were excluded specifically as riparian buffers in the derivation of the timber harvesting land base (the remainder being excluded for other reasons such as inoperability).

A.3.2.12 Exclusion of specific, geographically defined areas

No specific geographically defined areas were removed. The Greeley Creek watershed, identified in TSR 2 as potentially unharvestable for a number of reasons, was excluded under the operability reductions in this timber supply review.

A.3.2.13 Timber licence reversions

Timber licences are old tenure arrangements that give a licensee exclusive rights to harvest merchantable timber within the licence area and do not contribute to the TSA allowable annual cut. Once these areas have been harvested, regenerated, and have attained free-growing status, the timber licence area reverts to Forest Service jurisdiction. Accordingly, these areas are included in the timber harvesting land base after the first harvest and contribute to the TSA harvests in mid- to long-term.

Table A-12. Timber licence reversion schedule

Timber licence #	Location	Expiry year	Area to be harvested under the current forest development plan (hectares)
TO 451	Pingston Creek	2025	390
TO 467	Vanstone Creek	2025	211

Data source and comments:

Only two timber licences exist in the Revelstoke TSA and the last of these agreements expires in 2025.

Areas under timber licence tenure that were covered in stands less than 70 years of age were assumed to already be harvested and entered the timber harvesting land base at the start of the analysis horizon. Of the areas over 70 years of age, the following assumptions were made — 601 hectares of the oldest stands were assumed to be the ones under cutting permit and likely to be harvested. These areas were deferred from the timber harvesting land base for the first twenty years of the analysis horizon. They then were 'harvested' (the volume harvested did not contribute to the timber supply for the TSA) and entered the timber harvesting land base at age 0. The remaining stands over 70 years of age were allowed to age as deferred stands for twenty years and then allowed to contribute to timber supply.

A.4 Forest Management Assumptions

A.4.1 Harvesting

A.4.1.1 Utilization levels and waste and breakage (W2B) factors

The utilization levels define the maximum stump height, minimum top diameter (inside bark) and minimum diameter at breast height by species and are used in the analysis to calculate merchantable volume.

Table A-13. Utilization levels

Analysis unit	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Pine	12.5	30	10
Cedar > 140 years old	17.5	30	15[a]
Cedar < =140 years old	17.5	30	10
All other species	17.5	30	10

(a) Although actual utilization is to 15 cm — the volume curves reflect 10 cm, reflecting limits of the yield model.

Data source and comments:

These levels reflect current interior utilization standards, licence requirements and current performance. The VDYP growth and yield models do not support a 15 centimetre minimum top diameter-inside-bark (dib); however, a study of the difference between a 10 cm and a 15 cm minimum top dib showed a difference in volume of less than 1%.

A.4.1.2 Volume exclusions for mixed-species stands

Table A-14. Volume exclusions for mixed species types

Inventory type groups	Species	Volume exclusion (%)
All coniferous leading (1-34)	Any deciduous	100

Data source and comments:

The volume exclusion pertains to only the deciduous portions of coniferous-leading types. The deciduous portion may still contribute to biodiversity and coarse woody debris objectives at the stand level.

A.4 Forest Management Assumptions

A.4.1.3 Minimum harvestable age derivation

Culmination age is the age at which the stand reaches its maximum average annual growth increment (measured in cubic metres of volume per hectare produced in a year, and referred to as culmination mean annual increment or CMAI). For existing, natural old-growth and thrifty stands, a combination of two criteria were used to determine minimum harvestable ages (the oldest age of the two became the minimum harvest age): the age at which CMAI is reached, and the age at which a specified minimum stand volume was reached. For existing natural stands, the age to a 25 cm dbh was not used as a criterion for calculating minimum harvestable ages. This is because VDYP does not a provide an estimate of the age at which the trees have an average dbh of 25 centimetres, but rather the age at which all stems have reached the minimum of 25 centimetres.

For existing managed and future managed stands, three criteria were used. The first was the age at which 95% of the CMAI wold be reached. (These assumptions are consistent with district practice to limit harvesting in younger age classes, based upon knowledge that the achievement of culmination age will maximize the long-term harvest level). Also, two additional criteria were used: the age at which a specified minimum volume was achieved, and the age at which the average dbh of the largest 250 trees in the stand was projected to be 25 centimetres. The oldest of these three ages was used to set the minimum harvestable age for the stands in each managed-stand analysis unit. For managed stands, the age to achieve 95% of CMAI proved to be the most limiting factor in the determination of minimum harvestable ages.

A.4 Forest Management Assumptions

Table A-15. Minimum harvestable age criteria (existing unmanaged stands)

	Species	Site index cutoffs	AU	CMAI[a] (m^3/ha/yr)	Age to CMAI (years)	Age to 95% CMAI (years)	Minimum volume criterion (m^3/ha)	Age to min.vol. (years)	Age to 25 cm dbh[b] (years)	MHA (years)
Existing natural (VDYP)	Fir Larch Pine	All	014	2.37	130	95	150	80	Not used	130
	Cedar	≥ 17.5	021	3.50	80	70	200	70		80
	Cedar	≥14.5 to < 17.5	022	2.85	90	75	200	80		90
	Cedar	< 14.5	023	2.16	90	80	200	110		110
	Hemlock	≥18	031	4.23	80	70	200	60		80
	Hemlock	≥12 to < 18	032	2.91	100	85	200	85		100
	Hemlock	< 12	033	1.90	160	130	200	122		160
	Balsam Spruce	≥ 18	041	3.50	90	70	150	58		90
	Balsam Spruce	≥13 to < 18	042	2.18	120	90	150	83		120
	Balsam Spruce	< 13	043	1.37	160	130	150	125		160
	Spruce mix	≥ 18	051	4.07	80	70	150	55		80
	Spruce mix	≥14 to < 18	052	2.87	110	90	150	72		110
	Spruce mix	< 14	053	2.17	140	115	150	92		140
	Fir Larch Pine	≥ 21	111	3.45	100	75	150	58		100
	Fir Larch Pine	>15 to < 21	112	2.38	110	90	150	78		110
	Fir Larch Pine	< 15	113	1.47	140	110	150	120		140
	Cedar	≥ 17.5	121	3.52	80	69	200	70		80
	Cedar	< 17.5	124	2.24	90	78	200	105		105
	Hemlock	≥ 18	131	3.97	80	69	200	63		80
	Hemlock	≥12 to < 18	132	2.65	100	82	200	90		100
	Hemlock	< 12	133	1.79	150	125	200	130		150

(a) CMAI = culmination mean annual increment

(b) Minimum DBH (diameter breast height) criteria was not used for existing unmanaged stands

(continued)

A.4 Forest Management Assumptions

Table A-15. Minimum harvestable age criteria (existing unmanaged stands) concluded

Species	Site index cutoffs	AU	CMAI[a] (m^3/ha/yr)	Age to CMAI (years)	Age to 95% CMAI (years)	Minimum volume criterion (m^3/ha)	Age to min.vol. (years)	Age to 25 cm dbh[b] (years)	MHA (years)
Balsam Spruce	≥ 18	141	3.08	90	75	150	64		90
Balsam Spruce	≥13 to < 18	142	2.23	110	85	150	80		110
Balsam Spruce	< 13	143	1.42	160	125	150	121		160
Spruce mix	All	154	3.02	100	84	150	69		100
Deciduous[c]	All	264	1.04	90	70				20
Spruce/Cedar[d] (backlog 2)	All	464	2.04	80	70	200	100		70
Spruce/Cedar[d] (backlog 1)	All	564	2.46	90	70	200	85		70

(a) CMAI = culmination mean annual increment.

(b) Minimum DBH (diameter breast height) criteria was not used for existing unmanaged stands.

(c) The minimum harvestable age was set to 20 years for deciduous stands to reflect their conversion to coniferous leading stands in the first 20 years of the analysis horizon.

(d) The minimum harvestable ages for the backlog stands were set at 95 per cent CMAI.

A.4 Forest Management Assumptions

Table A-16a. Minimum harvestable age criteria for existing managed stands

	AU	Species	Site index cutoffs	CMAI[a] (m³/ha/yr)	Age to CMAI (years)	Age to 95% CMAI (years)	Minimum volume criterion (m³/ha)	Age to min.vol. (years)	Age to 25 cm dbh[b] (years)	MHA (years)
Managed	211	FdCwS	≥ 21	4.99	105	80	150	55	55	80
(TIPSY)	212	FdCwHw	≥15 to < 21	2.91	140	105	150	75	75	105
	213	FdCwS	< 15	1.57	155	130	150	115	115	130
	221	Cw	≥ 17.5	4.84	115	90	200	60	55	90
	222	Cw	≥14.5 to < 17.5	3.21	125	95	200	80	75	95
	223	Cw	< 14.5	2.27	140	120	200	105	90	120
	231	Hw	≥ 18	4.66	105	85	200	60	55	85
	234	Hw	< 18	2.87	135	110	200	90	80	110
	241	SxBl	≥ 18	4.79	80	75	150	55	55	75
	242	SxBl	≥13 to < 18	3.15	115	105	150	75	75	105
	243	SxBl	< 13	2.22	160	135	150	100	100	135
	251	SxCwFd	≥ 18	4.66	95	80	150	55	55	80
	252	SxCwFd	≥14 to < 18	3.08	120	100	150	75	75	100
	253	SxCwFd	< 14	2.12	155	130	150	100	100	130

(a) CMAI = culmination mean annual increment.

(b) Minimum average DBH (diameter breast height) of the largest 250 stems.

A.4 Forest Management Assumptions

Table A-16b. Minimum harvestable age criteria for future managed stands

	AU[a]	Species	Site index cutoffs	CMAI[b] (m³/ha/yr)	Age to CMAI (years)	Age to 95% CMAI (years)	Minimum volume criterion (m³/ha)	Age to min.vol. (years)	Age to 25 cm dbh[c] (years)	MHA (years)
Managed	211f	FdLP	≥ 21	4.69	110	85	150	55	60	85
(TIPSY)	212f	FdLP	≥15 to < 21	2.85	130	100	150	75	75	100
	213f	FdP	< 15	1.59	135	105	150	105	105	105
	221f	SxCwFd	≥ 17.5	4.76	95	80	150	55	55	80
	222f	SxCwFd	≥14.5 to < 17.5	3.23	110	95	150	70	70	95
	223f	SxCwFdHw	< 14.5	2.38	130	115	150	90	90	115
	231f	SxCwFdHw	≥ 18	4.7	100	80	150	55	55	80
	232f	SxCwFdHw		2.86	120	100	150	80	75	100
	233f	FdSxHw	< 18	1.81	160	140	150	110	105	140
	241f	SxBl	≥ 18	4.65	85	75	150	55	55	75
	242f	SxBl	≥13 to < 18	3.25	115	100	150	75	70	100
	243f	SxBl	< 13	2.23	160	135	150	100	100	135
	251f	SxCwFd	≥ 18	5.56	85	70	150	50	50	70
	252f	SxCwFd	≥14 to < 18	3.24	110	95	150	70	70	95
	253f	SxCwFd	< 14	2.16	145	125	150	95	95	125
	564f	HwCwFdS		4.38	110	90	200	65	60	90

(a) An "f" in the analysis unit number denotes a future managed stand.

(b) CMAI culmination mean annual increment.

(c) Minimum average DBH (diameter breast height) of the largest 250 stems.

A.4 Forest Management Assumptions

A.4.1.4 Harvest scheduling priorities

Stands making up cutting permit areas (category A blocks) have first priority for harvest for the first decade of the analysis horizon. Cedar- and spruce-leading stands are given a second priority (analysis units 021, 022, 023, 051, 052, 053 and 041) for the first three decades of the analysis horizon. The remaining coniferous-leading stands were harvested according to the relative oldest first harvest rule, which priorizes those stands that are oldest stand relative to their minimum harvestable age.

Table A-17. Priorities for scheduling the harvest

Description	Management zone	Species group	Period (10 year increments)	Priority (1 – 100)
Cutting permit area (category A)	Any	Any	1	1
Cedar and spruce	All	Cedar and spruce leading	1 – 3	2

A.4.1.5 Natural disturbance in forest outside the timber harvesting land base

Two sources of data were examined in order to determine an appropriate level of natural disturbance to model in the non-timber harvesting land base for the Revelstoke TSA. Initially, the data in the *Biodiversity Guidebook* was examined to determine appropriate natural disturbance return intervals for the biogeoclimatic zones and the natural disturbance types (NDTs) in the Revelstoke TSA. Expected natural disturbance regimes vary for ESSF NDT 1, ICH NDT 1 and ICH NDT 2 areas (all NDT2 in the Revelstoke TSA is in the ICH biogeoclimatic zone. Given the return intervals in the *Biodiversity Guidebook*, the rate of disturbance in the Revelstoke TSA non-timber harvesting land base was estimated to be about 300 hectares per year. No natural disturbance was assumed in NDT 5 areas, which comprise about 3000 hectares of non-timber harvesting land base.

The *Biodiversity Guidebook* suggested a percentage of area expected to be occupied by stands over 250 years of age for each NDT and biogeoclimatic combination. This percentage was used to develop a forest cover constraint for the non-timber harvesting land base portions in the base case to ensure that the area of forest over 250 years old did not drop below the *Biodiversity Guidebook* values. Stands on the non-timber harvesting land base were grouped into analysis units (according to whether they were in ESSF NDT1, ICH NDT1 or in ICH NDT2). The forest cover constraints were applied by landscape unit to the groupings of stands.

Natural disturbance was modelled as a harvest, although no volume contribution was assumed from the disturbed stands. Harvest targets were set for the stand groups to reflect the disturbance. No forest cover requirements (e.g., for biodiversity or wildlife habitat) were violated in order to meet the natural disturbance regime. In order to ensure the area was disturbed at the rate expected to emulate natural disturbance, it was necessary to reduce the harvest age to 50 years. At higher minimum harvest ages, the model was inclined to reserve areas from disturbance to meet other old-growth constraints such as for caribou, and did not allow the appropriate disturbance rate. The relatively young age also reflects the fact that natural disturbances are random events that can affect stands of varying ages, and not just old stands.

Following the initial design of the disturbance regime, the district calculated fire disturbance values in the non-timber harvesting land base, and noted that a value of 600 hectares per year, based on a summary of fire losses in the inoperable between 1995 and 2003, would be more reflective of what was being currently observed in the TSA than the 300 hectares per year derived from the *Biodiversity Guidebook*. The professional opinion of district staff was that these higher disturbance rates were more representative for the TSA than the rates suggested by the *Biodiversity Guidebook*. Therefore, the rates of disturbance in the base case were increased to a total of 598 hectares per year, to reflect the fire data and district observations.

Table A-18. Natural disturbance rates outside of the timber harvesting land base

NDT	Per cent (%) old growth to be retained	Old-growth age (years)	Total area (hectares)	Area to be disturbed annually – base case (hectares)	Area to be disturbed annually – *Biodiversity Guidebook* (hectares)
1 ESSF	49	250	89 309	349	182
1 ICH	37	250	43 393	215	109
2[a]	29	250	6 673	34	18
Total			**138 947**	**598**	**309**

(a) All NDT2 in the Revelstoke TSA is in the ICH biogeoclimatic zone

A.4 Forest Management Assumptions

A.4.1.6 Silvicultural systems

Generally in the TSA, the harvesting system is clearcut. In the caribou zone, some harvesting has taken place as small patch cuts.

The table below indicates the degree to which clearcut and alternate silvicultural systems are used in the Revelstoke TSA. The percentage breakdowns are for the total area actually harvested between 1997 and 2002.

Table A-19. Silvicultural systems

Silvicultural system	Per cent (%) of total harvested area in Revelstoke TSA (1997-2002)
Clearcut	70
Clearcut with wildlife tree reserves	20
Total clearcut	90
Alternate systems patch/group	10

Data source and comments:

Patch harvesting/group selection is considered by Columbia Forest District operations staff to be an alternate system (although it is an even-aged stand management method similar to clearcutting) because it involves the harvesting of smaller areas. Group selection systems in the Revelstoke TSA are considered by district operations staff to be similar to patch systems, as both are generally deployed for similar purposes and results. Therefore, the areas harvested by patch and group selection systems have been combined in the table. There has been an increase in the use of patch/group systems due to the management of caribou habitat areas and the development of district forest cover requirements for managing this habitat.

All yield tables used in this analysis are derived assuming even aged stands due to the small amount of alternate systems used.

The current application of the patch/group system in the Revelstoke TSA (particularly the caribou zone) can generally be described as follows: harvested openings approximately one hectare in size, with the occasional retention of wildlife trees and wildlife tree patches within the opening. The caribou habitat forest cover requirements were slightly modified in the analysis to account for the modelling of only clearcut harvest rather than some component of partial cutting (see footnote (b) in Table A-28., "Other forest cover requirements").

A.4 Forest Management Assumptions

A.4.2 Unsalvaged losses

The purpose of this section is to provide an estimate of average annual unsalvaged volume loss to insect and disease epidemics, fires, wind damage or other agents on the timber harvesting land base. The unsalvaged loss column only reflects those areas in which the volume will not be recovered or salvaged.

Table A-20. Unsalvaged losses (based on 1995-2001 data)

Cause of loss	Unsalvaged loss (hectares/year)	Average volume (m^3/ha)	Unsalvaged loss ($m^3/year$)
Wildfire	30.1	209	6 300
Broadcast/fringe burn	5.0	391	1 959
Total fire	35.1	235	8 259
Hemlock looper	1.5	300	450
Spruce bark beetle	0.0	0	0
Douglas-fir bark beetle	0.6	350	210
Total pests/insects	2.1	314	660
Windthrow/blowdown	0.7	328	230
Avalanche	0.2	350	70
Total loss	38.1	242	9 219

Except for wildfire losses and losses due to fringe damage from prescribed burning, unsalvaged losses were based on information collected for the last TSR. The results were slightly adjusted to address changes in trends since the last TSR. The information used in the last TSR was collected from the Revelstoke Forest District staff, licensee annual reports, MLSIS/ISIS (silviculture databases), and Forest Insect Disease Survey (FIDS) reports. The best data available was used for the analysis which often consisted of 'professional judgment' as information sources. Data was pooled from different sources, often in different units of measure, and brought together to form a unified product.

Fringe damage losses are based on information supplied by the licensees. Wildfire losses (from 1995 to 2001) were based on the protection fire reporting system and the professional judgment of district staff.

In the analysis, the harvest targets set for each decade included 9219 cubic metres per year of unsalvaged losses. This volume was then deducted from the harvest levels shown on the figures in the analysis report.

As noted in the title of the unsalvaged losses table above, the estimate of unsalvaged losses used in the base case was based on information from 1995 through 2001. However, addition of new information on fires from 2003 to the data set used to estimate unsalvaged losses, increases the overall estimate to 27 748 cubic metres per year. The average annual area lost to wildlife from 1995 to 2003 is 77.2 hectares, and the average stand volume in those areas is 313 cubic metres per hectares. Areas and volumes lost to other factors remain the same. The new information highlights the uncertainty associated with estimating unsalvaged losses, since data from a single year can greatly alter estimates. It is impossible to know with certainty the correct time span over which to measure such losses, in particular because future weather and economic conditions are difficult to predict. An attempt is made to gather information for as long a time frame as possible while trying to ensure that the data used apply within the context of current protection and salvage programs. A sensitivity analysis was done to examine the impacts of uncertainty in the estimate of average unsalvaged losses.

A.4 Forest Management Assumptions

A.4.3 Silviculture

A.4.3.1 Regeneration activities in managed stands

Growth in both recent plantations and future stands was projected using managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. Volumes for existing managed stands (stands on the timber harvesting land base currently aged 25 years or less) were projected separately from the volumes for future managed stands due to different species compositions. For existing managed stands, actual stand species compositions were used and an average area-weighted site index value for each analysis unit was calculated. Table A-21. shows the information used in developing yield tables for existing managed stands.

For future managed stands, average site indices were calculated based on area-weighted site indices of the areas projected to enter each analysis unit following harvest. Table A-22. shows the information used for developing growth and yield projections for future managed stands, including the existing analysis units that are regenerated to each future managed analysis unit, regeneration regime, site index and operational adjustment factors for account for openings in the stand and future losses to decay.

No thinning was assumed, based on the initial density values. Regeneration delays reflect current operational practice. Regeneration delays were applied in the FSSIM forest estate model not in the TIPSY yield model. Provincial average operational adjustment factors (OAFs) values were applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch, as no local values are available. It should be noted that there is some concern that these OAFs may underestimate the losses expected in some stands due to root disease.

A.4 Forest Management Assumptions

Table A-21. Growth and yield assumptions by analysis unit – existing managed stands

Species group code[a]	Analysis unit numbers	Regeneration		Average site index metres	Regen delay years	OAFs (%)		Regeneration species[a] composition	Density (stems/ha)	
		Method	%			1	2		Initial	Thin
F, L, P	211	Planted	100	22.9	2	15	5	Fd76Cw12S07Hw05	2000	N/A
	212	Planted	100	17.2	2	15	5	Fd65Cw17Hw10S08	2000	N/A
	213	Planted	100	13.1	2	15	5	Fd65Cw20S10Hw05	2000	N/A
C	221	Planted	100	19.2	2	15	5	Cw58Hw18Sw15Fd09	2000	N/A
	222	Planted	100	15.7	2	15	5	Cw56Hw16S16Fd12	2000	N/A
	223	Planted	100	13.0	2	15	5	Cw59Hw21S10Fd10	2000	N/A
H	231	Planted	100	18.8	2	15	5	Hw53Cw27S16Pl 04	2000	N/A
	234	Planted	100	14.2	2	15	5	Hw50Cw25S14Fd11	2000	N/A
BS & SB	241	Planted	100	20.6	2	15	5	S82Bl11Hw04Cw03	2000	N/A
	242	Planted	100	15.0	2	15	5	S84Bl12Hw03Cw01	2000	N/A
	243	Planted	100	11.2	2	15	5	S76Bl18Hw05Cw01	2000	N/A
S (mixed)	251	Planted	100	19.8	2	15	5	S62Cw22Hw11Fd05	2000	N/A
	252	Planted	100	15.1	2	15	5	S60Cw22Hw10Fd08	2000	N/A
	253	Planted	100	11.6	2	15	5	S61Cw22Hw11Fd06	2000	N/A

(a) Codes taken from the Vegetation Resources Inventory B.C. Land Cover Classification Scheme document—Section 1, Table 6.2.

A.4 Forest Management Assumptions

Table A-22. Regeneration and growth and yield assumptions by analysis unit – future managed stands

Analysis unit numbers	Initial analysis unit[a]	Regeneration		Average site index metres	Regen delay years	OAFs (%)		Regeneration species[a] composition	Density (stems/ha)	
		method	%			1	2		Initial	Thin
211f	111	Planted	100	23.2	2	15	5	Fdi60Lw30Pli10	2000	N/A
212f	014,112	Planted	100	17.8	2	15	5	Fdi60Lw30Pli10	2000	N/A
213f	113	Planted	100	13.4	2	15	5	Fdi50Pli50	2000	N/A
221f	021,121	Planted	100	19.0	2	15	5	Sx50Cw40Fdi10	2000	N/A
222f	022,124,264	Planted	100	16.0	2	15	5	Sx50Cw40Fdi10	2000	N/A
223f	023	Planted	100	13.7	2	15	5	Sx50Cw20Fdi20 Hw10	2000	N/A
231f	031,131	Planted	100	19.9	2	15	5	Sx40Cw30Fdi20 Hw10	2000	N/A
232f	032,132	Planted	100	14.7	2	15	5	Sx40Cw30Fdi20 Hw10	2000	N/A
233f	033,133	Planted	100	13.9	2	15	5	Fdi50Sx40Hw10	2000	N/A
241f	041,141	Planted	100	21.6	2	15	5	Sx90Bl10	2000	N/A
242f	042,142	Planted	100	15.1	2	15	5	Sx90Bl10	2000	N/A
243f	043,143	Planted	100	10.4	2	15	5	Sx90Bl10	2000	N/A
251f	051	Planted	100	21.4	2	15	5	Sx60Cw30Fdi10	2000	N/A
252f	052,154	Planted	100	15.6	2	15	5	Sx60Cw30Fdi10	2000	N/A
253f	053	Planted	100	11.8	2	15	5	Sx50Cw30Fdi20	2000	N/A

(a) In addition to the analysis units listed in this column, existing managed stands regenerate to future managed yield tables after harvest and reforestation. Existing managed analysis units regenerate to the same corresponding future managed stand analysis unit number (e.g., 211 goes to 211f).

Genetic worth values were applied in the base case based on the TSA's current allocation of orchard seed (current genetic gain) to future regenerated stands. Spruce, larch, and western white pine orchard seed is currently being used. However, only spruce values were applied in the base case since spruce comprises the bulk of the planting stock from these species (larch is projected to be planted on about 3% of the timber harvesting land base at the end of the 400-year analysis horizon, and white pine planting was not projected in the analysis). Sensitivity analysis was conducted to evaluate the effect of regenerating all stands with improved seed.

A.4 Forest Management Assumptions

Table A-23. Genetic worth

Seed production unit	Current genetic gain (%)
Sx – all	3.77

Note: Improved seed results for Lw, Pli and Pw were not included in the analysis as they are planted in very low numbers (considered insignificant).

A.4.3.2 Immature plantation history

This section identifies areas of existing immature forest where the density (stems per hectare) was controlled and therefore should be assigned to a managed stand yield curve (MSYT). All current NSR areas and future harvested stands were assigned to MSYTs.

Table A-24. Immature plantation history

	Area managed (%)
Analysis unit	Age 1- 25 years
211-253	100

Data source and comments:

Recently regenerated areas (under 26 years old) are assumed to be performing as managed stands due to increased silvicultural activities during that time.

A.4.3.3 Not satisfactorily restocked (NSR) areas

Land classified in the TSA FIP file as type identity 4 or 9 that were not excluded as a result of the other exclusion criteria applied (such as for inoperable areas, problem forest types, or low productivity sites), is included in the timber harvesting land base. Type identities 4 and 9 indicate not satisfactorily restocked (NSR) land base.

A.4 Forest Management Assumptions

Table A-25. Not satisfactorily restocked (NSR) areas

Not satisfactorily restocked (NSR)	Analysis unit (AU)	Area in silviculture records (hectares)	Area on FIP file (hectares)	Area used in timber supply analysis (hectares)
Current NSR	Fd leading	29		437
	Cw or Hw leading	556		815
	S or Ba leading	208		231
Total		795	1483	800
Backlog NSR (< 60 per cent MSS)	464	745	1850	699
Backlog NSR (>= 60 per cent MSS)	564	1105		1028

Data source and comments:

District silviculture data from ISIS and MLSIS were used in conjunction with the data on land classified as NSR in the FIP file. The data in the silviculture records (ISIS and MLSIS) were determined to most accurately reflect the amount of NSR area.

Current NSR:

The FIP file identified more 683 hectares more NSR area than did the silviculture records. The excess area was assumed to be regenerated already and the stands were assigned an age of 5 years in the analysis. It is assumed that all current NSR will reach satisfactory stocking within 2 years according to the same profile as indicated in the silvicultural records.

However, the current site indices and leading species information on the FIP file for the stands were used to assign existing managed stand analysis units to the current NSR areas. Therefore, the proportions of area in the analysis units based on leading species is somewhat different than indicated by the silviculture data.

Backlog:

District summaries of NSR denuded before 1988 indicate the amount of yield reduced area.

It was not possible to differentiate stands with more or less than 60% stocking from the data in the FIP file. Therefore, all NSR stands older than 11 years of age were assigned to either analysis unit based on the number of hectares expected to be in each category from the ISIS/MLSIS data. The excess 661 hectares of backlog NSR stands on the FIP file were assumed to have been treated and regenerated already at full stocking and were assigned to managed stand analysis units based on the existing leading species information.

1028 hectares of NSR land were assumed to have more than 60% stocking and were assigned to analysis unit 564, and 699 hectares were assigned to analysis unit 464. The stands in both analysis units are an aggregate of backlog cedar/hemlock/spruce/balsam areas.

The NSR figures are associated with areas that have been harvested.

VDYP was used to determine yields for the stands in backlog analysis units as the stands on these areas are not currently being managed to a level that warrants assignment to a managed stand yield table. Therefore, the growth of the stands is better reflected on natural stand yield curves.

A.4 Forest Management Assumptions

Table A-26. Regeneration assumptions for backlog NSR analysis units

Analysis unit	Current species composition	Current crown closure (%)	Volume adjustment factor	Regeneration		Regeneration species[a] composition
				Method	Per cent (%)	
564 (> 60% MSS[b])	$Cw_{33}S_{32}Hw_{20}$ $Fd_{10}Bl_5$	46	0.90	Planted	100	$H_{50}C_{30}Fdi_{10}S_{10}$
464 (< 60% MSS[b])	$Cw_{36}S_{31}Hw_{17}$ Fd_9Bl_7	46	0.75	Planted	100	$H_{50}C_{30}Fdi_{10}S_{10}$

(a) Codes taken from the Vegetation Resources Inventory B.C. Land Cover Classification Scheme Document—Section 1, Table 6.2.

Explicit regeneration delays were not modelled for the backlog stands in the analysis as the stands were already regenerated. A normal regeneration delay (2 years) was assumed for the stands regenerated after harvest of the existing NSR (i.e., after they have achieved minimum harvestable age).

A.4 Forest Management Assumptions

A.4.4 Integrated resource management

A.4.4.1 Objectives which require forest cover requirements

Table A-27. Forest cover requirements for landscape biodiversity

Biogeoclimatic unit(s)	NDT	Biodiversity option	Mature & old-seral stage		Old-seral stage[a]			
					Maximum retention area (%)			
			Minimum retention area (%)	Minimum age (years)	Now	66 years	136 years	Old-seral age (years)
ESSF wc1, wc2, wc4,vc	1	Low	19	120	19.0	19.0	19.0	250
Parkland		Intermediate	36	120	19.0	19.0	19.0	250
		High	54	120	28.0	28.0	28.0	250
ICH wk1, vk1	1	Low	17	100	13.0	13.0	13.0	250
		Intermediate	34	100	13.0	13.0	13.0	250
		High	51	100	19.0	19.0	19.0	250
ICH mw2, mw3	2	Low	15	100	9.0	9.0	9.0	250
		Intermediate	31	100	9.0	9.0	9.0	250
		High	46	100	13.0	13.0	13.0	250

(a) The full old requirement was used in the low BEO for the base case.

Data source and comments:

The biodiversity targets for old- and mature-forests are based on the *Landscape Unit Planning Guide*. These targets were applied as per the MAC strategy. This strategy has been endorsed by government but not made into a higher level plan. It has been reflected in the district manager's development plan directional letters since before the last timber supply review. Licensees have been voluntarily abiding by the strategy. The strategy differs from the *Landscape Unit Planning Guide* in the following ways:

- High and intermediate biodiversity emphasis options are deployed within defined corridors within a landscape unit.
- The mature plus old target must be met.
- The full old-seral target in must be met initially in areas with a low BEO (i.e., no phase-in).
- Seral targets must be met both the above and below the operability line on the Crown forested land base (i.e., the proportional representation rule).

When modelling seral requirements for biodiversity it was assumed that all stands in the non-contributing forest will be disturbed according to an average natural return cycle (see Section A.4.1.5, "Natural disturbance in forest outside the timber harvesting land base."

A.4 Forest Management Assumptions

Table A-28. Other forest cover requirements

Zone or group	Green-up height (metres)	Green-up maximum allowable disturbance %	Older age (years)	Minimum area of older age retained (%)	Land base constraints apply to
Caribou ESSF Above caribou line	2	25	140	70	Crown productive forest area below 80% slopes
Caribou ESSF[a,b] Below caribou line	2	25	140	40	Crown productive forest area below 80% slopes
			250	10	
Caribou ICH Above caribou line	2	25	140	70	Crown productive forest area below 80% slopes
Caribou ICH[a] Below caribou line	2	25	140	40	Crown productive forest area below 80% slopes
			250	10	
Intermediate caribou[c]	2	25			Crown productive forest within intermediate caribou habitat
ICH			100	34	
			250	13	
ESSF			120	36	
			250	19	
Caribou immature[d]					Crown productive forest within the delineated immature habitat area
Ungulate winter range Deer leading	2	25	120	40	Crown productive forest
Ungulate winter range Moose leading	2	25	120	40	Crown productive forest
Domestic watershed	6	25	N/A	N/A	Total crown forest
Community watershed	6	25			Total crown forest
IRM zone[e]	2	25	N/A	N/A	Timber harvesting land base
Visual quality retention	6	5	N/A	N/A	Visual landscape unit Crown productive forest
Visual quality partial retention	6	15	N/A	N/A	Visual landscape unit Crown productive forest
Visual quality modification	2	25	N/A	N/A	Visual landscape unit Crown productive forest

(a) The area of mapped immature patches in the caribou zone were not included for determining targets for the first rotation of 80 years.

(b) Forest cover requirements in the MAC strategy for the ESSF below the caribou line indicates that 30% of the forested area must be maintained in age class 8 or older, and at least 1/3 of this 30% must be in age class 9. On an additional 20% (minimum) of the area partial cutting prescriptions are employed which maintain suitable caribou habitat attributes. Because data of sufficient detail and accuracy is not available to model partial cutting prescriptions using FSSIM a 40% forest cover target was used for stands greater than 140 years of age for this zone.

(c) The caribou habitat indicated as intermediate received the seral requirements for old and mature forests as described for the intermediate Biodiversity Emphasis Option. Intermediate caribou habitat has been identified in the ESSFvc, ICH wk1 and ICH vk1.

(d) There is no harvesting in the caribou immature areas for the first 80 years of the analysis horizon, after which forest cover requirements associated with the type of habitat are applied. See Table 9 of the main report.

(e) The integrated resource management zone encompasses that portion of the timber harvesting land base not occupied by any other zone or group, aside from biodiversity emphasis.

A.4.4.2 Reductions to reflect volume retention in cutblocks

Wildlife trees (WT) and tree patches (WTP)

The *Landscape Unit Planning Guide* describes methods for maintaining stand structure over time. Wildlife tree requirements as described in the *Landscape Unit Planning Guide* were determined based on Table A3.1 of the *Guide* (for situation in which landscape units have been designated and landscape-level biodiversity objectives have been established). The retention percentages were based on the assumption that 50% of the wildlife tree requirements will be met from forested areas outside the timber harvesting land base. It was assumed that all clearcut harvesting prior to 1996 (obtained from the ISIS database) was harvested without wildlife tree patches and all areas harvested in 1996 and beyond, wildlife tree patches were retained. Wildlife tree requirements were calculated for each landscape unit and biogeoclimatic subzone. In the analysis, a percentage of each forest cover polygon in each landscape unit/biogeoclimatic subzone combination was excluded in the derivation of the timber harvesting land base, using the percentages in the table below.

Most wildlife trees are left in patches adjacent to cutblocks, and are expected to persist over at least two rotations. Many of these patches are greater than two hectares in size and can contribute to old-seral stage forest requirements at the landscape level. In the analysis, the areas excluded as wildlife tree patches were considered in the meeting of landscape-level biodiversity objectives.

Table A-29. Reductions to reflect volume retention in cutblocks

Biogeoclimatic unit	Wildlife tree retention required (% of cutblock area)
ESSFvc	6.7%
ESSFwc 1	1.6%
ESSFwc 4	3.8%
ESSFwc2	5.9%
ICH mw 2	2.8%
ICH mw 3	2.4%
ICHvk1	3.2%
ICHwk1	3.9%

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.5a developed and supported by the B.C. Ministry of Sustainable Resource Management, Resource Information Branch, was used to estimate timber volumes for existing natural stands and backlog stands. Yield curves were generated for each polygon, and then area-weighted into one aggregate yield curve for each analysis unit. The table below shows the area-weighted volume estimates by 10-year age class for each existing natural stand analysis unit.

Table A-30. Existing unmanaged stand volume estimates (cubic metres/hectare)

Age (years)	Leading species									
	Fir larch pine old all 014	**Cedar old good 021**	**Cedar old medium 022**	**Cedar old poor 023**	**Hemlock old good 031**	**Hemlock old medium 032**	**Hemlock old poor 033**	**Balsam spruce old good 041**	**Balsam spruce old medium 042**	**Balsam spruce old poor 043**
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	1	2	0	0	2	0	0	0	0	0
40	16	58	30	5	63	6	0	37	4	0
50	49	113	79	43	136	43	0	108	22	5
60	86	164	124	80	199	97	9	169	63	16
70	121	210	163	114	254	148	39	221	105	37
80	155	252	200	145	302	194	77	265	142	61
90	186	282	227	168	336	230	113	301	174	84
100	214	307	249	187	363	259	144	330	201	105
110	240	326	266	203	383	284	171	354	225	124
120	263	340	279	215	399	304	195	375	245	141
130	285	366	301	234	422	328	220	393	266	159
140	306	391	323	252	442	349	243	410	284	175
150	325	414	343	269	460	369	264	424	300	190
160	341	436	362	285	475	386	283	436	315	205
170	356	457	379	299	488	401	299	447	328	218
180	371	477	396	314	500	415	314	457	340	231
190	384	496	412	327	510	426	328	465	351	243
200	397	514	428	340	520	438	341	472	361	254
210	410	532	443	353	530	450	354	478	371	265
220	422	553	461	368	538	461	366	484	379	275
230	434	573	478	382	546	471	378	489	387	284
240	445	593	495	397	553	481	389	493	395	293
250	455	612	512	411	559	489	399	497	401	302
260	457	613	514	413	562	493	406	499	405	305
270	459	614	516	415	565	497	413	501	408	308
280	460	615	517	417	567	500	419	502	410	311
290	461	616	518	419	569	503	425	503	412	314
300	463	617	519	420	570	506	429	504	414	317
310	464	618	520	422	572	509	434	505	416	319
320	465	619	522	423	573	511	438	505	418	321
330	466	619	522	424	575	513	441	506	419	323
340	467	620	523	425	576	516	445	506	420	325
350	468	621	524	426	577	517	448	506	421	326

(continued)

A.5 Volume Estimates for Existing Stands

Table A-30. Existing unmanaged stand volume estimates (cubic metres/hectare)

Age (years)	Leading species										
	Spruce mix old good 051	Spruce mix old medium 052	Spruce mix old poor 053	Fir larch pine thrifty good 111	Fir larch pine thrifty medium 112	Fir larch pine thrifty poor 113	Cedar thrifty good 121	Cedar thrifty medium & poor 124	Hemlock thrifty good 131	Hemlock thrifty medium 132	Hemlock thrifty poor 133
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	14	2	0	6	0	6	0	0
40	44	2	0	59	24	1	63	14	64	9	0
50	126	28	2	111	59	12	117	52	130	45	1
60	197	89	19	160	96	32	167	88	188	92	10
70	257	144	60	207	130	55	210	121	238	136	40
80	306	193	105	250	162	78	250	151	281	176	73
90	344	233	145	288	191	98	278	174	313	208	103
100	374	267	180	321	218	117	301	192	338	235	131
110	398	295	210	349	243	135	320	208	357	258	156
120	417	319	237	373	263	151	334	220	372	276	178
130	437	343	263	397	283	165	357	237	393	297	200
140	455	363	287	418	301	179	379	254	411	316	220
150	470	382	308	438	317	190	400	269	427	333	238
160	484	398	327	456	331	201	419	283	440	348	254
170	495	413	344	473	344	210	436	296	452	361	268
180	505	426	359	488	357	219	453	309	463	372	281
190	514	437	373	503	368	227	468	321	472	383	293
200	522	447	386	516	380	236	484	332	482	393	304
210	530	457	398	530	390	244	499	343	490	404	316
220	537	466	409	542	400	251	516	356	498	413	326
230	543	474	419	554	410	259	533	369	505	422	336
240	549	481	428	566	419	266	549	382	512	430	346
250	555	488	437	577	428	273	564	395	519	438	355
260	557	492	443	578	430	275	566	397	521	441	361
270	559	496	448	579	431	276	567	399	523	444	366
280	560	499	453	580	432	278	568	400	525	447	370
290	561	501	457	581	434	280	569	402	527	449	374
300	562	504	461	581	435	281	570	403	529	451	378
310	563	506	464	582	436	283	571	405	531	454	382
320	564	508	467	583	437	284	571	406	532	456	385
330	564	509	470	584	438	285	572	407	534	457	388
340	564	511	472	584	438	287	573	408	535	459	390
350	565	512	475	585	439	288	573	409	536	461	393

(continued)

A.5 Volume Estimates for Existing Stands

Table A-30. Existing unmanaged stand volume estimates (cubic metres/hectare) (concluded)

Age (years)	Leading species					
	Balsam spruce thrifty good 141	**Balsam spruce thrifty medium 142**	**Balsam spruce thrifty poor 143**	**Spruce mix thrifty all 154**	**Cedar spruce hemlock fir backlog, <60% stocking 464**	**Cedar spruce hemlock fir backlog, >60% stocking 564**
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	3	1	0	0	1	1
40	28	12	1	15	35	42
50	86	40	9	53	73	88
60	140	78	24	106	107	129
70	188	116	49	156	137	164
80	228	149	72	200	163	196
90	261	177	94	236	184	221
100	289	202	114	266	202	242
110	312	224	132	292	217	260
120	331	242	148	313	229	275
130	350	262	165	334	245	294
140	368	281	181	353	260	312
150	384	298	196	369	273	328
160	398	314	211	384	286	343
170	411	328	224	397	297	356
180	422	342	237	408	308	369
190	433	355	249	419	318	382
200	442	367	261	428	328	393
210	451	378	272	437	337	405
220	459	389	282	445	348	418
230	467	399	293	453	359	430
240	474	409	302	460	369	443
250	480	418	312	467	379	455
260	482	421	314	470		
270	484	423	317	473		
280	486	425	319	476		
290	488	427	322	478		
300	489	429	324	480		
310	490	430	326	482		
320	491	431	328	484		
330	492	433	329	485		
340	493	434	331	487		
350	494	435	332	488		

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 3.2, supported by the B.C. Ministry of Forests', Research Branch, was used to estimate growth and yield for existing managed and future managed stands. The area-weighted site index for each analysis unit was used, along with regeneration assumptions, as input to TIPSY.

A.6 Volume Estimates for Regenerated Stands

Table A-31. *Existing managed stand volume estimates (cubic metres/hectare)*

Age (years)	Leading species								
	Fir cedar spruce good 211	Fir cedar hemlock medium 212	Fir cedar spruce poor 213	Cedar good 221	Cedar medium 222	Cedar poor 223	Hemlock good 231	Hemlock medium & poor 234	Spruce balsam good 241
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	2	0	0	0	0	0	1	0	1
40	47	1	0	24	1	0	27	0	37
50	143	25	1	107	26	2	108	9	127
60	227	72	8	202	82	19	198	53	221
70	307	131	25	287	147	60	280	108	310
80	376	186	51	352	208	104	350	166	381
90	443	228	81	419	266	148	410	217	428
100	498	271	112	480	312	190	464	266	459
110	549	310	143	532	350	229	510	307	485
120	594	344	169	580	385	265	554	343	504
130	630	377	194	619	420	294	590	375	519
140	661	406	214	652	451	318	621	401	524
150	685	431	233	687	476	339	647	428	528
160	685	450	249	720	501	356	673	450	532
170	685	472	264	751	524	371	699	469	532
180	685	489	279	778	543	388	722	488	532
190	685	502	292	800	562	404	743	504	532
200	685	516	303	818	574	418	759	520	532
210	685	531	313	834	587	431	773	533	532
220	685	545	324	854	598	444	787	544	532
230	685	558	334	871	610	458	803	557	532
240	685	570	343	888	622	468	803	569	532
250	685	579	349	903	636	479	803	578	532
260	685	586	355	916	648	489	803	585	532
270	685	594	362	932	660	496	803	591	532
280	685	600	369	932	670	507	803	597	532
290	685	605	377	932	679	515	803	602	532
300	685	611	381	932	691	520	803	609	532
310	685	611	381	932	691	520	803	609	532
320	685	611	381	932	691	520	803	609	532
330	685	611	381	932	691	520	803	609	532
340	685	611	381	932	691	520	803	609	532
350	685	611	381	932	691	520	803	609	532

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-31. Existing managed stand volume estimates (cubic metres/hectare) (concluded)

Age (years)	Leading species				
	Spruce balsam medium 242	Spruce balsam poor 243	Spruce mix good 251	Spruce mix medium 252	Spruce mix poor 253
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	0	0	0
40	0	0	28	1	0
50	13	0	111	14	0
60	59	2	205	64	5
70	122	21	289	127	28
80	183	55	361	187	66
90	235	95	418	241	107
100	289	141	464	291	151
110	337	179	503	334	188
120	374	216	533	369	223
130	399	251	555	395	258
140	419	285	578	419	291
150	434	314	595	439	315
160	449	340	610	456	338
170	460	360	622	472	355
180	468	376	634	485	368
190	474	390	642	497	380
200	480	401	650	504	391
210	485	410	657	513	400
220	486	419	665	519	408
230	485	426	672	524	416
240	483	431	677	528	423
250	484	437	677	532	429
260	483	442	677	535	434
270	483	444	677	539	438
280	482	446	677	540	443
290	478	450	677	542	445
300	477	451	677	548	448
310	477	451	677	548	448
320	477	451	677	548	448
330	477	451	677	548	448
340	477	451	677	548	448
350	477	451	677	548	448

A.6 Volume Estimates for Regenerated Stands

Table A-32. *Future managed stand volume estimates (cubic metres/hectare)*

Age (years)	Regenerating species								
	Fir larch pine good 211f	**Fir larch pine medium 212f**	**Fir pine poor 213f**	**Spruce cedar fir good 221f**	**Spruce cedar fir medium 222f**	**Spruce cedar fir hemlock poor 223f**	**Spruce cedar fir hemlock good 231f**	**Spruce cedar fir hemlock medium 232f**	**Fir spruce hemlock poor 233f**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	1	0	0	0	0	0	0	0	0
40	39	6	6	17	2	0	29	1	0
50	127	33	22	92	29	4	110	10	1
60	203	78	49	184	91	33	202	54	10
70	279	136	80	266	159	80	285	111	35
80	348	183	108	336	223	134	352	167	71
90	413	223	137	396	282	180	411	218	112
100	465	264	160	445	329	226	460	267	150
110	511	299	182	485	367	269	503	306	184
120	552	328	200	523	403	305	538	339	216
130	582	359	217	550	430	333	567	366	244
140	609	383	232	575	455	357	594	391	267
150	630	406	245	594	479	376	620	411	290
160	648	424	258	613	496	395	641	432	308
170	664	439	268	634	514	408	659	448	323
180	677	452	275	650	527	422	676	465	336
190	690	463	284	663	539	433	690	477	348
200	703	475	290	674	547	445	699	487	356
210	714	483	298	683	554	454	713	497	367
220	720	492	304	693	560	461	722	508	374
230	724	495	308	703	567	470	730	513	382
240	728	504	313	711	575	476	744	520	390
250	734	507	316	720	583	482	744	525	395
260	738	510	320	727	592	485	744	534	400
270	740	516	322	736	599	489	744	536	404
280	740	517	323	742	606	493	744	539	406
290	741	517	327	742	612	493	744	545	409
300	743	517	328	742	619	494	744	549	413
310	743	517	328	742	619	494	744	549	413
320	743	517	328	742	619	494	744	549	413
330	743	517	328	742	619	494	744	549	413
340	743	517	328	742	619	494	744	549	413
350	743	517	328	742	619	494	744	549	413

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-32. Future managed stand volume estimates (cubic metres/hectare) (concluded)

Age (years)	Regenerating species						
	Spruce balsam good 241f	**Spruce balsam medium 242f**	**Spruce balsam poor 243f**	**Spruce cedar fir good 251f**	**Spruce cedar fir medium 252f**	**Spruce cedar fir poor 253f**	**Hemlock cedar fir spruce 564f**
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	1	0	0	1	0	0	0
40	56	1	0	52	1	0	16
50	165	16	0	158	22	1	89
60	260	68	1	259	79	7	174
70	355	133	13	345	145	31	251
80	413	195	40	416	206	68	319
90	450	250	78	471	264	109	377
100	477	306	120	516	316	148	431
110	498	351	160	554	355	184	482
120	508	384	195	584	384	217	526
130	509	408	228	610	412	250	565
140	511	426	262	630	434	277	602
150	510	441	297	651	455	301	634
160	510	453	323	666	473	319	661
170	510	462	345	679	487	334	688
180	510	470	364	689	499	347	711
190	510	475	376	699	511	358	732
200	510	480	390	707	517	369	753
210	510	484	400	707	522	375	770
220	510	482	408	707	529	383	790
230	510	480	417	707	534	390	806
240	510	479	423	707	539	397	821
250	510	477	426	707	541	404	835
260	510	477	431	707	547	408	847
270	510	474	435	707	553	415	858
280	510	473	438	707	558	421	869
290	510	469	440	707	561	423	877
300	510	468	442	707	566	427	
310	510	468	442	707	566	427	
320	510	468	442	707	566	427	
330	510	468	442	707	566	427	
340	510	468	442	707	566	427	
350	510	468	442	707	566	427	

Appendix B

Socio-Economic Analysis Background Information

B.1 Definition of Forest Industry Activities

The socio-economic analysis identifies employment and income impacts, changes in government revenues and community impacts at various harvest levels and times in the future. Some of the assumptions used in the analysis are as follows:

- Employment multipliers — these multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. Employment multipliers are calculated based on analytical assumptions and data collected at a specific time. Consequently, the multipliers reflect industry and employment conditions at that time and may not accurately reflect future industry conditions. In any impact analysis, the information should be considered as an indicator of magnitude.
- Employment coefficients — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, employment coefficients may change in future as a result of changing market conditions or production technologies, for example.
- Timing of impacts — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Also, indirect and induced impacts will likely occur over a longer period, as business and consumer spending levels adjust to changes in harvest levels and associated spending.
- Processing thresholds — processing job impacts are unlikely to occur in direct proportion to harvest changes (i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction). Impacts are more likely to occur stepwise related to processing thresholds. A processing threshold is the level of a mill's timber supply that, when reached, will cause a mill to either lay off a shift or shut down the mill, temporarily or permanently. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. Over a number of years, however, the impact figures should be reasonably accurate.
- Proportional harvest reductions — harvest reductions are assumed to be spread proportionately among all licensees and forms of tenure.

B.2 ECONOMIC IMPACT METHODOLOGY

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA during TSR 2 (1998). Other general economic data are from BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and
3) timber processing.

Estimating employment and income impacts involves several steps. First, the current activity in each of the three sub-sectors was assessed. Then, indirect and induced employment and employment income impacts were estimated. Employment coefficients were calculated and applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes, were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log transport, log salvage, planning and administration functions. The employment multipliers used in this analysis define road building and maintenance work as indirect rather than direct employment. Including this employment in direct estimates would result in double counting.

Harvest employment coefficients from the TSR 2 Revelstoke SEA were used to estimate current average direct employment rates.

Two estimates of direct employment in harvesting are presented:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Most silviculture work is seasonal, consequently silviculture jobs were converted into equivalent full-time person-years of employment. Coefficients used in this report for TSA and provincial level silviculture employment are from TSR 2.

B.2 ECONOMIC IMPACT METHODOLOGY

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers: those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated similarly.

As with the harvesting sub-sector, direct employment coefficients from the TSR 2 Revelstoke SEA were used to estimate current average direct processing employment.

Indirect and induced employment estimates

Indirect employees associated with the forestry sector are those who supply goods and services to firms directly engaged in the basic forestry sector; for example, those who provide road maintenance services, fuel and office equipment and products. Induced employment consist of those who supply goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the induced impacts associated with a change in direct employment. Estimates provided in this report reflect the mid-point of these multipliers.

The TSA and provincial employment multipliers used in the Revelstoke TSA analysis are shown in Table B-1.

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial interior migration multiplier	Provincial interior no-migration multiplier
Harvesting	1.39	1.27	2.14	1.80
Solid wood processing	1.62	1.45	2.29	1.93
Pulp	N/A	N/A	3.02	2.48

Sources: Provincial multipliers: Horne, G., R. Riley, L. Ransom, and S. Kosempel. 1996. A provincial impact estimation procedure for the British Columbia forest sector.

Local area multipliers: Horne, Garry. "British Columbia's Heartland At the Dawn of the 21st Century: 2001 Economic Dependency and Impact Ratios for 63 Local Areas." January 2004. Victoria: Ministry of Management Services. 1999.

B.2 ECONOMIC IMPACT METHODOLOGY

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in the future. Therefore, the employment estimates should be viewed as indicators of the magnitude of change rather than as precise estimates of changes in employment levels.